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**DESIGNING A CHEMOTHERAPY INFUSION CENTER IN BUFFALO, NEW
YORK USING DAYLIGHTING TO AID IN THE HEALING PROCESS**

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Rochester Institute of Technology

Golisano Institute for Sustainability

Thesis, Master of Architecture Candidate 2021

Department of Architecture

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COMMITTEE APPROVAL

*Designing A Chemotherapy Infusion Center in Buffalo, New York Using Daylighting to Aid in
The Healing Process*

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To my late father, knowing that your dedication and love as a parent would have been pushing me to exceed and reach my goals gives me the motivation to conquer anything. I reach for the stars because I know you are there to guide the way. Rest easy, I love you.

ABSTRACT:

Healthcare makes up a large amount of infrastructure and while today's designs have vastly improved over the years, incorporating more natural light can improve not only staff's performance but also enhance a patient healing experience. Daylighting is one of the most powerful, natural product designers can use in projects. Healthcare facilities have a goal in mind when designing a hospital such as the patients healing, overall experience, and their comfort. To continue to achieve improvements in patient care, it is important to constantly evaluate current means and methods, with one element that influences the delivery of care is the design and construction of healthcare facilities themselves (Whitaker 2018). With personal experience, chemotherapy infusion bays in the past were typically a long corridor with chairs, dark paint colors and materials with very little windows. Through research a new proposed plan to incorporate more daylighting in cancer treatment centers, focusing primarily on infusion bays. By incorporating more daylighting in these areas will help with the body's circadian rhythm and assistance in the healing process. Natural lighting is a positive environmental stimulation that can decrease stress and improve the body's immune system. Weakened immune systems, stress and anxiety are just a few things cancer patients experience during treatment.

Key Words: Cancer Patients, Chemotherapy, Circadian Rhythm, Daylighting, Healthcare Architecture, Healing Architecture, Infusion, Sustainable Architecture.

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2. INTRODUCTION:

2.1 The Evolution in Healthcare Facilities

Years before the technology and education of today, hospitals were usually places people avoided and considered them as a last resort if they could not afford anything better.

Hospitals are a product of ever-evolving ideas of society, science, and that status of the medical community (Richard L. Miller 2021). Evidence of the first related hospital dates to 1200 B.C.E. and in 400 B.C.E., these hospitals were places where people worshiped but also sheltered the sick. Historians believed this was the first hospitals of the Western world, and they resembled spas, emphasizing exposure to fresh air, sunlight, rest, baths, exercise, and a reasonable diet (Richard L. Miller 2021). By the Renaissance era, hospitals resembled modern day designs. The beginning of the twentieth century the idea of a hospitals progressed, and the reputation increased, improving their target market and overall healthcare treatments. Throughout the decade's hospitals enhanced their technology. They have increased their social target market and most important have changed the overall design.

1.2 Healthcare Facility Design

Hospitals are rigid and difficult to adapt to expansion, renovation, and installation of new equipment due to specific guidelines and regulations. Through recent studies and observation, modern day hospitals are moving toward evidenced-based and green design. Any healthcare facility must be flexible and given current unprecedented times they must accommodate every changing demands.

Unlike commercial workplaces that have racetrack corridor designs giving them ample head count for employees, this method does not work well for most healthcare facilities. Physicians and nurses count their steps and typically spend more time walking than attending to patients, therefore long corridors are detrimental. Long corridors which typically are active, bustling, and noisy may increase a patients' stress levels. Also not only do employees have to walk long corridors so does the machinery to travel the same length to get to a patient in need. Thus, making racetrack and long corridors inefficient.

Overtime architects and designers moved forward to redesign and modify the racetrack design, by creating a central core which will house the essentials for the building such as storage and vertical circulation. This idea of flexibility within healthcare facilities also extends to the finishes. Interior designers who work on healthcare facilities must be cautious when choosing finishes. These materials must have a durability with their cleaning solutions and the hospital traffic including furniture and people.

Research shows that there are many challenges with making improvements in a healthcare facility. Each healthcare project has many requirements that influence the hospital design. A few regulations based off information from the International Building Codes (IBC), and Guidelines for Design and Construction of Healthcare Facilities, The Facility Guidelines Institute (FGI). The FGI includes ANSI/ASHRAE/ASHE Standard 170-2008, Ventilation of Healthcare Facilities.

1.3 Green Strategies throughout Healthcare Facilities

Through evidence-based design (EBD) studies show that incorporation of healthy patients' rooms such as those that have windows or better lighting will help in the aid of the

healing process. There is actually a phenomenon known as ICU syndrome, which occurs when a critically ill patient is subjected twenty-four hours a day to hard and unvarying fluorescent light, the incessant beep of monitors and thump of respirators, and the disorienting sameness of the stark white or sickly color walls – the syndrome consists of sleep disturbances, hallucinations, and, on occasion, mild psychosis (Richard L. Miller 2021). Creating a room with a window that has a sort of nature shot will only benefit in the healing process with patients.

Studies in the benefit of nature and healthy biophilic cities can help understand just the benefits of what nature can do for an individual. Only brief encounters with nature or the outdoors can deliver a significant emotional and health benefits. There are many kinds of health benefits that nature in cities can deliver; some are more direct – as when a hike in the woods serves to reduce stress hormone levels (Timothy Beatley 2018). Below is a list of direct and indirect pathways, that nature can serve to positively influence health:

- i. Watching, seeing, listening to actual nature outside
- ii. Hiking, Camping, Spending time out of doors
- iii. Feeling the window, rain, mist on one's body.
- iv. Purposeful enjoyment of outdoor nature – gardening, tree planting, cleaning up garbage from a stream or beach.
- v. Participating in a nature club or organization
- vi. Watching nature through a window
- vii. Experiencing indoor nature (e.g., looking at a terrarium, aquarium, indoor green wall)
- viii. Watching images of nature on a computer screen
- ix. Reading about nature
- x. Attending a lecture about nature
- xi. Contemplating nature or a memory of a previous experience

Implementing biophilic design in healthcare systems is not just an added amenity, but it has proven economic, social, and health benefits to all regardless of age, gender, race, or ethnicity.

1.3.1 Synergenial Design

Hospital and healthcare facilities take on a dynamic design and in other words can be described as a Synergenial design which is a concept that buildings are functional environments that evoke positive responses from their users on physical, intellectual, and emotional levels. Breaking that down, Synergism and geniality are the component terms of the concept-are key elements of a design approach that acknowledges both the synergistic nature of the problem-solving process and the congenial, user-sensitive attributes of a successfully designed solution” (Richard L. Miller 2021) . Evaluating the design and concept behind synergism starts with the five P’s, people, purpose, price, place, and perspective.

1.3.2 Sick Buildings

Sick Building Syndrome started in the 1980’s when office buildings become more “airtight” for an economic standpoint. While these offices had a racetrack layout, the exterior offices on the windows usually were higher employees such as CEO’s or meeting rooms. With offices that occupied the entire window the amount of daylighting entering the space was reduced, the health and emotional state of employees that were working in cubicles were frequently sick, unhappy, and less motivated.

Sick buildings not only are harmful to the patients but also the employees. Research notices that patients exposed to noise or stuck in a windowless room require stronger painkillers, become more anxious or even delirious more readily and often more depressed. When patients have a room with a window to nature their blood pressure drops, they are less anxious and

depressed. Studies have shown that when a patient's anxiety increases, the immune system is suppressed, and the body is weakened in its ability to fight disease (Richard L. Miller 2021).

1.4 Understanding Cancer

Not many people know what cancer is unless they themselves or they know someone who has experienced cancer firsthand. Unfortunately, cancer does not discriminate, either in sex, age, or race. Cancer can develop anywhere in the body and usually starts when cells grow out of control and grow out normal cells. In the current day and age many people can be successfully treated for their cancer, but there are various types of cancer. It is not just one disease; cancer can start in any part of the body and grow and spread to the rest of it. What makes cancer so frightening, it is a complex group of diseases and there can be multiple causes that create a type of cancer, lifestyle habits, genetics, carcinogens, environmental factors, and sometimes there is no obvious cause.

There are four stages of cancer – one, two, three and four. Each cancer diagnosis is different and can be found at any stage. Cancer is typically treated by surgery, medicines (drugs), and radiation which usually depends on what type of cancer and the stage it is at. Many times, drugs are used to kill the cancer cells or slow their growth, most common methods are given by IV or pills. Chemotherapy (Chemo), targeted therapy, immunotherapy, and hormone therapy are options, but chemo is usually the most used method. Radiation is an additional treatment that can happen simultaneously with chemo or is used prior to surgery.

Fatigue is one of the most frequent side effects of cancer treatment and according to several studies, this symptom affects up to 70% of patients during chemotherapy (Dimeo, et al. 1999). Side effects are different for each individual and include anemia, loss of appetite, flu-like

symptoms, hair loss, memory or concentration problems, nausea, pain, sleep problems and insomnia. In most cases simple everyday tasks can feel like a marathon for a cancer patient and their mental and emotional state become distressed. With these types of side effects and the powerful treatments it can take a toll on a person's body weakening their immune system.

1.5 Healing Architecture

In the English language the term *to heal* means “to make whole” – such wholeness can be psychological, physical, and social or all three at once. Healing through architecture can be done in several ways, but for this proposed project, increasing natural light and incorporating a biophilic aspect will be observed. Research shows that exposure to gardens and other forms of nature can help heal in a physical sense along with various forms of medical care to foster recover from illness by reducing bad effects of stress on the immune system (Timothy Beatley 2018). With the stress that is induced by hospitalization is commonly found amongst all patients caused by the loss of physical capacities, painful medical procedures, fear, and uncertainty. With depression, high blood pressure, and the release of potent stress-induced hormones weaken the immune system delay the process of healing the patient.

By creating a space that includes increase in daylighting, enlarged windows if not additional windows, clear wayfinding systems, single-occupant patient rooms, noise reducing materials and a simple view to nature can positively affect a patient's sense of well-being. Though these design features above cannot simply cure a patient's disease, the individual will benefit from the sense of the psychological wholeness and tranquility by experiencing at least one of these features.

1.5.1 The “Mood” and Spatial Experience

Architecture can be defined in many ways but during the eighteenth century, architecture was defined as an art of persuasion that had the ability to speak to its viewers, by expressing its purpose to them by affecting their emotions such as “mood”. With this term being used scarcely today, it can be interpreted by introducing healing architecture such as increasing the daylighting that enters the space, giving windows to all patient rooms, increasing the existing windows, and creating views to the exterior that shows some aspect of nature (water, trees, etc.)

Spatial experience was evident in architectural practice in the ancient world (Asfour 2020). To execute a design that includes the ideas of spatial experience connect with its users, and is shown with proportion of light, texture, solid and void, form structure, along with other aspects of space-making. With updating technologies and increase in production, these ideas for spatial experiences have been pushed aside. Steen Rasmussen author of *Experiencing Architecture* states “it is not enough to see architecture: you must experience – you must dwell in the rooms; feel how they close about you [...] to be created in a special spirit and they convey this spirit to others”. Throughout the book it is explained that the feature of “mood” architecture is to be conveyed by light and shade, solid and void, textures, scale and proportions, rhythm, and color.

1.5.2 Color

Lighting and color are the most important pieces to any individual and has become an important factor in design and construction. There are many color theory discussions that can be used by a designer for influence on color choice. Studies in color theory shows an increase in positive health benefits such as a decrease in heart rate, blood pressure, respiratory rate, body

temperature and can be used to treat cancer, depression, and bacterial infections (Li 2018).

Light colors reflect and bounce light easily compared to dark colors which usually hold in the heat and restrict the space. This influences future healthcare designs to use light choices in paint and materials to benefit patients. Knowing that light colors can physically improve an individual's health from the previous list, another option is to incorporate these colors into window designs. In Table #1, shows the different light colors and at what wavelength those color reach, that will benefit the human body. Light color shows a relation between two distinct hormones such as cortisol and melatonin. The blue spectrum which is found mostly during the morning and afternoon times, increases the cortisol in a human body. Cortisol gives the individual energy, which influences the body to wake up and be active. The red spectrum is typically found in the late afternoon and at dusk, this creates the melatonin hormone. Melatonin increases an individual to become more tired, and less active. These affects can be used by tinting glass for areas where direct light can be limited or little to no outdoor view. For healthcare, green colors are usually not recommended as it creates an unsettling, sickening feeling for an individual. But blue is thought to be calming, sedative, peaceful, demonstrated by the peaceful nature of water, the sky, and the ocean (Hulme 2002).

Light Color	Wavelength in nanometer
Violet	390 - 455 nm
Blue	455 - 492 nm
Green	492 - 577 nm
Yellow	577 - 597 nm
Orange	597 - 622 nm
Red	622 - 780 nm

Table 1 - Light Color Chart Shows Appropriate Wavelength To Positively Affect The Human Body, By A Nabil.

Daylighting and the benefits will be later discussed however in a video “Dynamics of Daylighting Inside Out” lectured by Marilyn Andersen, she explains the use of tinted glass and the benefits. Window tinting and different paned windows allow for the space to become more sustainable, but it can also include more benefits to the individuals who occupy the space. Andersen explains that during her case studies cooler colored windows such as blue tones received the most data. Individuals felt more comfortable, accomplished more work, and simply felt at ease in a space with blue tinted glass. Andersen also talked about solar shades which help control the amount of daylighting and solar gain in a space. Research mentions that the shading device shape can also influence a person emotionally, affecting their performance in a space. Color does not apply to the interior finishes but can also be applied in different forms such as window glazing.

1.5.3 Daylight

Daylighting is researched repeatedly by various architects as it provides serious health benefits to individuals who occupy that given space. For instance, patients in hospitals or health facilities will benefit from the increase in daylighting into their room and the employee’s health and mood will also increase in said workspaces. There are studies that prove the best placement of windows in different healthcare facilities for daylighting and outdoor views. For both patients and workers, stress, mood, activities, and satisfaction can fluctuate. The physiological and psychological benefits of daylighting have made it an increasingly important topic in multidisciplinary research (Gharaveis 2016). Lighting as a positive environmental stimulation can decrease stress, negative feelings, and even anxiety. Light is effective in reducing depression and can improve moods. Satisfaction can be affected by daylighting or well light areas, according to some researchers, building occupants prefer daylighting rather than electrical

lighting in indoor spaces during the day, and this architectural tool can include user perception and satisfaction. With benefits to the physiological and psychological of an individual, daylighting will also benefit the circadian rhythm which will later be explained.

Secondly, daylighting becomes a sustainable feature in today's architecture. Using daylight can decrease a buildings energy cost down by using less artificial lighting, the negative is that it will increase the use of mechanical equipment such as heating and cooling. Studies show that a standard three foot by five-foot window can equal up to 100 60-watt lamps. An average one-foot window area can light about 40 square feet of floor space on an overcast day while the same window area can light 133 square feet of floor space on a clear sunny day. Daylighting can range between 100 to 2,000 Lux of illuminance, whereas the range of 500 to 2,000 is most desirable for any functional space.

In a sustainable manner working with natural light verse artificial light is increasing better on many factors including health of occupants, work mentality, and overall mood. Table 2 shows about a quarter of the illuminance required for hospital areas. This chart was pulled together to form what specific illuminance that are needed for the proposed project. Now 100 lux of natural light equals about 10 foot-candles, 500 lux equals 47 foot-candles, and 2,000 lux is 128 foot-candles. According to Table 2 the format of the foot-candles ranges from 10 to 50 foot-candles. Ideally the goal is to range between 300 to 600 Lux of natural light throughout the proposed space. Reaching over 2,000 Lux (128 fc) is unbearable and extremely detrimental to the eye.

Area/Activity	Illuminance (Foot-Candles)
Central Sterile Supply	
Work Areas	50
Processed Storage	30
Charting	50
Corridors	
Day	20
Night	10
Hand Wash Locations	30
Laboratories	
General - additional task lighting as required	50
Linens	
Sorting Soiled Linen	30
Central (clean) linen room	30
Nurses Stations	
General	30
Desk	50
Medication station	75
Nourishment Room	30
Patient Holding Areas	75
Patients/Residents Rooms	
General (Entire Room	20
Observation-night lighting	3
Critical Examination	75 (may be portable)
Toilets/Bathing	
General (Includes water closets, shower/tub)	30
Night Lighting	3

Table 2 - Appropriate Hospital Illuminance For Specific Area/Activities, By Michigan Department Of Licensing & Regulatory Affairs.

1.5.4 Vegetation

The concept behind the benefits of nature comes from research that states nature is a living element. Sights to the outside and bright light help patients and staff but the actual view is not always important. Most cases state that nature itself is very beneficial to the healing process but in other cases this is not true. Having a view at trees, flowers, and running water may be what is wanted but in some case, studies having a view to an exterior corridor or plaza may also have the same effect as a tree would. In an interview with Elise, she was asked what the view was at her infusion bay. She states that the view was of downtown Buffalo. When asked if this bothered her, she responded with “I enjoyed the city view, it helped me only because I’m a busy body and like to see action of what’s always going on”. Therefore, a view to outside is critical but not always what the elements are.

1.5.5 Circadian Rhythm

Aside from the health effects without daylighting present, the circadian rhythm is extremely beneficial to an individual’s body. Morning light prompts the pineal gland to switch off the production of melatonin while the night prompts the production of melatonin easing an individual to sleep in a sense of a schedule. The sleep-wake cycle is not the only things the circadian rhythm stimulates, it stimulates the body temperature, insulin production, and various functions relating to the endocrine, kidney, and sex organs. It also influences the brain, the pineal gland which regulates our sensation of hunger and thirst, as well as influencing our mood and sense of well-being (Baker 2002). Having a reasonable sleep-wake cycle will give an individual between six to eight hours of sleep which is said to be the correct amount for an individual’s health and to properly function. Studies show that following the natural circadian rhythm can improve an individual’s health, so incorporating natural daylighting into a space and by placement of patient rooms and ICU rooms will prompt healing.

1.6 Problem Statement:

The goal for healthcare facilities is to make all occupants feel safe and happy, with the current state of Roswell Park there are mixed emotions from both employees and patients. Including more daylight into a new infusion center will not only aid in the healing process and increase moods of the patients and workers but also creating a sustainable functioning building. Keeping in touch with an individual's circadian rhythm helps heal the body, ease the mind, and rise serotonin levels. The proposed plan is creating a new cancer treatment center focusing on the benefits of natural light and introducing more of a biophilic design. Through interviews the treatment center will also allow more seating options for patients whether this be group, private or semi-private infusion chairs. Understanding color and the effects they can play in human psychology and with lighting will influence the color palette for the proposed design. With LEEDs' daylit floor area by achieving illuminance levels between 300 – 3,000 Lux of 75% of floor space, in mind, designing a building to those standards of increasing daylighting and reinforce the circadian rhythm can be analyzed through the healing process of a patient.

2. Precedent Studies

2.1 Roswell Park Comprehensive Cancer Center

Founded in 1898, Roswell Park Comprehensive Cancer Center was the first center in the world to focus exclusively on cancer. The multidisciplinary teams are board-certified surgical, medical and radiation oncologists to ensure patients treatments are on track with respect to everyone. Information provided from Roswell's website, George H.A Clowes, PhD pioneered

new methods in chemotherapy research in 1904, which is recognized to current day for the effective cancer treatment. Roswell is also the first to conduct many new tests and results but one being the photodynamic therapy (PDT) which combines laser light and light sensitive drug, cause a reaction that kills cancer cells almost 80 years later in 1978.



Figure 1 - Original Building Of Roswell Park Comprehensive Cancer Center, Cancer Treatment Center – Provided By Google Maps.

Roswell Park has conducted many new remodels and expansions in their parcel. One specific being a remodel on the Scott Bieler Clinical Sciences Center has influenced designs to incorporate more daylighting into the chemotherapy infusion bays. Figure 1 simply shows what the original cancer treatment facility looks like for almost 20 years before the Scott Biel Clinical Sciences Center opened their doors in 2016. From personal experience, years ago infusion bays

use to be dark, cold, and felt very isolated (can be seen in figure #). With improvement in design and knowledge of color theory and daylighting infusion bays have come a long way. The new treatment center has severely increased with this remodel. Figure 2 shows the current treatment center. An 11 story, 142,000 square foot space that now houses Breast Oncology and Imaging Center, Chemotherapy and Infusion Center and Gynecology center, along with two new centers dedicated to meeting long-term needs of patients who are no longer active. The new and improved structure constructed out of steel and glazing allow for a one-of-a-kind structure new to Roswell Park.



Figure 2 - Scott Bieler Clinical Sciences Center – Provided By Laura Constantin.

2.2 The University of Virginia, University Hospital Expansion/Perkins and Will

Area: 440,000 square feet

Year: 2020

City: Charlottesville

University of Virginia Health System's emergency departments and in-patient bed tower now offers an enhanced experience for patients and staff. The connection of nature to the patients and staff allows for greater flexibility in use of space, reduces stress, environmental impact, and allows for greater flexibility of the space and evolving medical technology.

A 28-foot-tall atrium with towering windows floods the space with natural light. Circular skylights spanning 12 feet in diameter. With light colored wood ceiling and white floors creates brightness and warmth.

Break rooms, eat-in kitchens, and other "back of the house" areas provide daylight and views to the outdoors. For the surgical teams who spend hours on end in an enclosed operating room, an adjoining glass corridor also with views to the outdoors. Curves improve sightlines between medical staff and patient rooms and add an interesting aesthetic touch.

Metal fins on the building's exterior reduce glare and heat, lowering energy consumption.

2.3 Parkland Health & Hospital System

Area: 2,100,000 square feet

Year: 2015

City: Dallas, TX

This was a complete replacement of the existing Parkland Memorial Hospital. From its inception, the design for the New Parkland Hospital has been distinctly about the medical center's relevance in connecting to the city's urban fabric.

The combination of physical relationship to multiple modes of public transportation and the incorporation of “linear parks” as major design elements for orientation and navigation. The contextual relationship of the building to the modern Dallas skyline led to the use of a low-iron glass curtain wall system that uses dot frit patterns to create a distinctive gradient on the bed towers.

The base is defined by a tree graphic that at a distance transform from a dense summer canopy on the western façade to a delicate branch pattern that covers the south-facing lobby.

2.4 Pluta Cancer Center



Figure 3 - Pluta Cancer Center Located Within Calkins Health Commons, Rochester, NY – Provided By Google Maps.

Wilmot Cancer Institute's Pluta Cancer Center is known for its compassionate care, provides outpatient medical and radiation oncology services. Pluta provided services to many patients no matter their type of cancer but the focus mostly on Comprehensive Breast Care. Their mission is to provide a coordinated multidisciplinary evaluation and treatment program

focused on individualized care for all aspects of breast health in a warm and healing environment. Understanding this current building based on exterior images only, shows that the two-story atrium at the entrance of the building shown in Figure 3 allows for natural light to fill the main lobby. Based on a second interview found in Appendix A by Phyllis Eddy states the interior of the infusion bays.

3. Background of Buffalo, New York

Buffalo is the second-largest city in Upstate New York. The city sits near Lake Erie and is a close travel distance to the Canadian border. During the 17th century Buffalo was inhabited by the Native American Iroquois tribe and later by French colonizers. Buffalo gained the name after an expedition of a British military engineer referencing the Buffalo Creek in a journal entry. The city later grew in the 19th and 20th century in the result of the Erie Canal and rail transportation. Like other cities, Buffalo has a handful of outstanding architectural buildings, annual festivities, and a thriving and progressive music and art scene. Buffalo is known for their good neighbors, chicken wings and their climate.

3.1 Geographical Location

Buffalo is located on level or gently rolling terrain on the edge of Lake Erie. The city has 52.5 square miles (136 km²), of which 40.6 square miles (105 km²) is land and the rest water. As mentioned above Buffalo sits on the North East edge of Lake Erie just opposite end of Fort Erie, Ontario, and Canada. With only 20 percent water, Buffalo Creek runs into Lake Erie and Niagara River runs into Niagara Falls and then into Lake Ontario making Buffalo an enjoyable water activity city.

3.2 Climate

Buffalo has a reputation for their winters - with its location right near the lake – below freezing winds come across the warmer lake and produces lake effect snow, in amounts higher than most northern states. The same winds that create lake effect also create cool breezes in the summer which can be helpful during the warmer months. Typically, the climate here is humid but Buffalo has the sunniest and driest summers of most major cities in the Northeast.

3.2.1 Temperature

The warm season lasts for 3.7 months, from May 29th to September 20th, with an average daily high temperature above 70 degrees Fahrenheit. The hottest day of the years is mid-July with an average high of 79 degrees Fahrenheit and the low of 65 degrees Fahrenheit. The cold season lasts for 3.3 months, from December 5th to March 13th with an average daily high

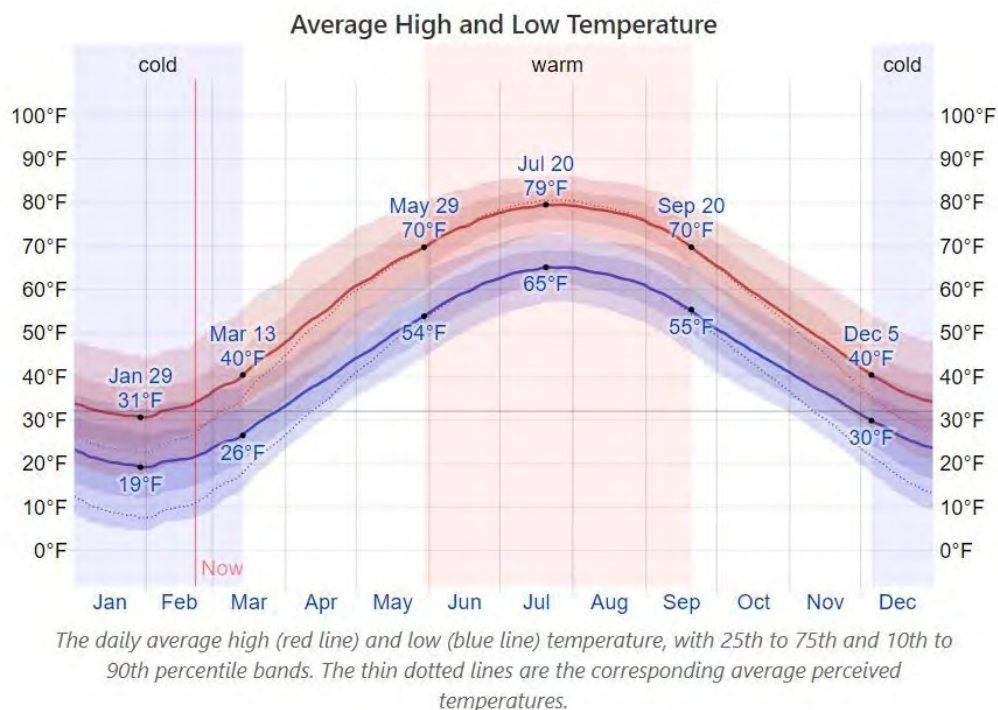


Figure 4 - Average High And Low Temperature During 12-Month Period For Buffalo, NY - Provided By Climate Consultant.

temperature below 40 degrees Fahrenheit. The coldest day year falls in late January, with an average low of 19 degrees Fahrenheit and a high of 31 degrees Fahrenheit.

3.2.2 Clouds

The average percentage of the sky covered by clouds experiences significant season variation over the course of the year. For about 6 months (May-November) are the clearer months. Studies show that August 8th is the clearest day of the year, the sky is clear, mostly clear, or partly cloudy 67 percent of the time. For the other almost 6 months of the year (November-May) are cloudy. Studies state that January 11th is the cloudiest day of the year, the sky is overcast or mostly cloudy 72 percent of the time.

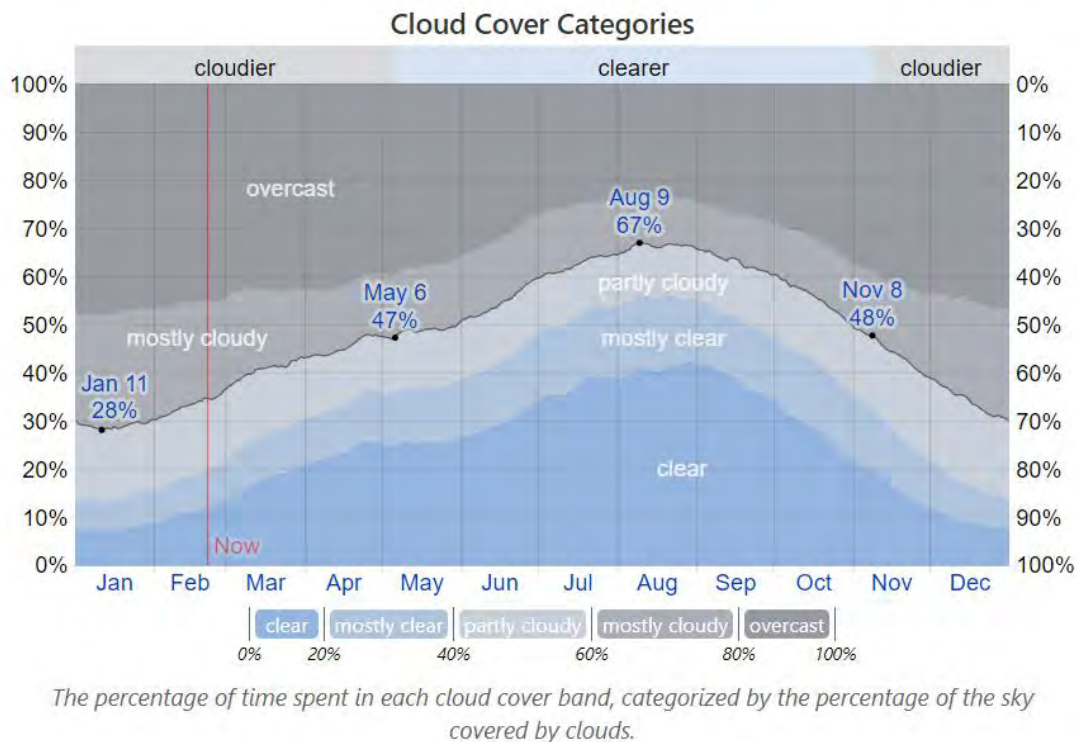


Figure 5 - Cloud Cover For A 12-Month Period In Buffalo, NY – Provided By Climate Consultant.

3.2.3 Sun

The length of the day in Buffalo varies significantly over the course of the year, in 2021 the shortest and longest day falls in the summer and winter solstice – December 21st and June 20th. The earliest sunrise is 5:36 AM on June 14th and the latest 7:56 AM on November 6th. The earliest sunset is at 4:41 PM on December 9th and the latest is 8:58 PM on June 26th. Daylight Savings Time (DST) is observed in Buffalo, lasting almost 8 months.

3.2.4 Snowfall

When measuring snowfall, it is in liquid-equivalent terms and the actual depth of new snowfall is typically between five to ten times the liquid-equivalent amount, assuming the ground is frozen. With Buffalo experiencing season variation in monthly liquid-equivalent snowfall. The snowy period usually lasts for 5 months, from November to April, but snowfall can begin earlier. The least snow falls around August 4th.

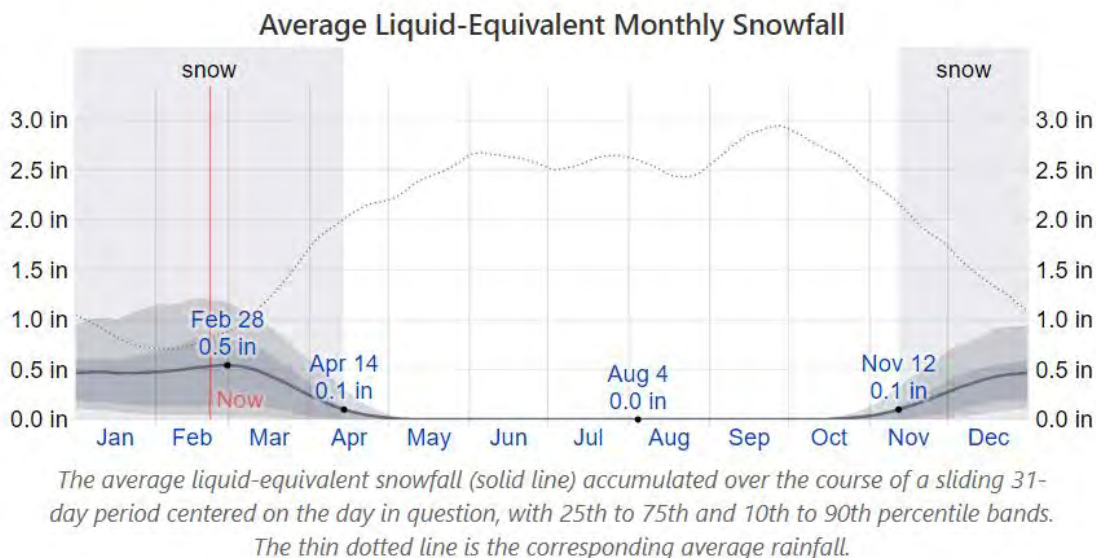


Figure 6 - Snow Fall For A 12-Month Period In Buffalo, NY – Provided By Climate Consultant.

3.2.5 Wind

Wind is usually measured in speed and direction and about 10 meters above the ground, therefore the average hourly wind speed in Buffalo experiences significant season variation over the course of the year. The windier part of the year lasts for almost 5 months between November to March, with average wind speeds of more than 8.9 miles per hour. The windiest day of the year is recorded of January 16th with speeds of 11.9 miles per hour. The calmer time of the year lasts for 7 months from March to November. The calmest day of the year recorded us August 4th, with an average hourly wind speed of 6 miles per hour. Since Lake Erie is West of Buffalo it makes sense that the predominant wind direction is from the West.

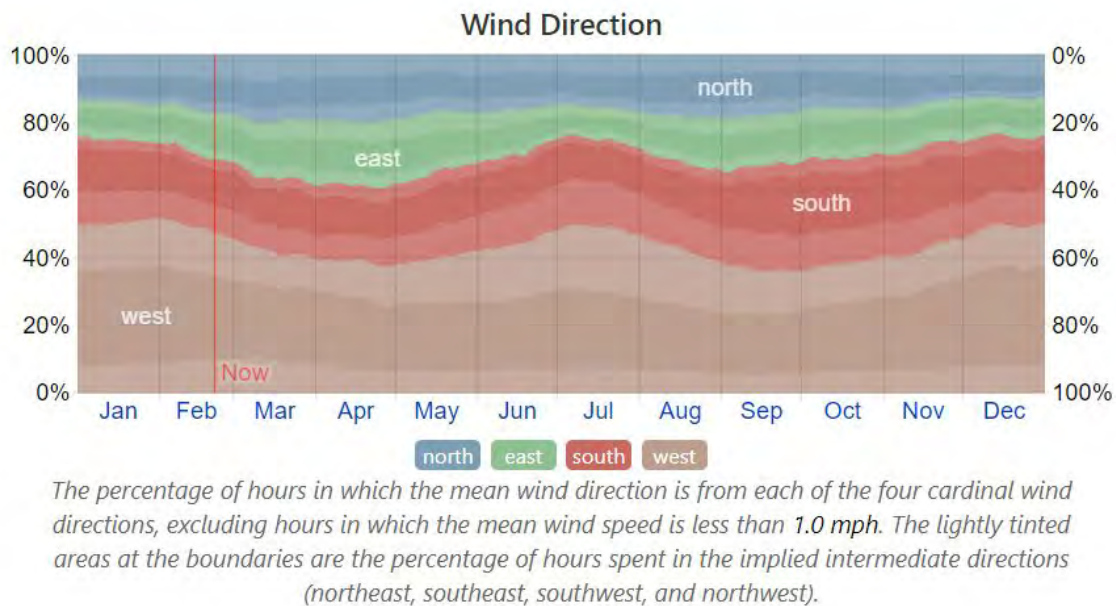


Figure 7 - Wind Direction Of A 12-Month Period In Buffalo, NY – Provided By Climate Consultant.

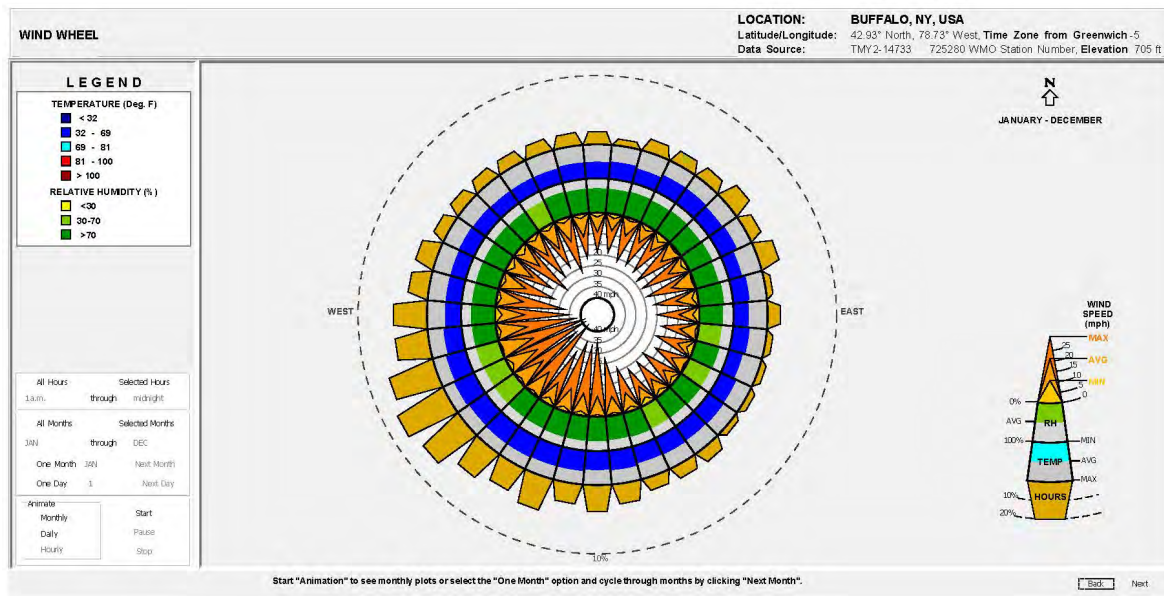


Figure 8 - Wind Rose Of 12-Month Period In Buffalo, NY – Provided By Climate Consultant.

4. Programming

There are specific rules and regulations to stand by when working in healthcare design. There are codes and regulations that must be followed and those can be found in “Guidelines for Design and Construction of Healthcare Facilities – The Facility Guidelines Institute”. With keeping the guidelines handy, the standard design for healthcare workers and the patients also plays a factor into the design. Healthcare workers are constantly on the move and designing a hospital that cuts down the number of steps a doctor or nurse take to help a patient is extremely helpful. The following categories are implemented throughout the design to positively reinforce the new treatment center.

4.1 Codes and Regulations

Within healthcare design comes many different rules and regulations in the design. With these facilities being places that are seen as clean and treating the critically ill, there must be guidelines to follow. Though there are phenomenon's known as ICU Syndrome which usually occurs when a critically ill patient is subjected 24 hours a day to hard and unvarying fluorescent lighting, the beep of monitors, thumps of respirators and the disorienting sameness of the white sickly colored walls – this syndrome consists of sleep disturbances and even hallucinations (Murphy 1998). With this becoming an issue there has been guidelines to follow such as making sure that ICU rooms have a window for daylight to fill the space.

4.2 Light and Views

In section 1.2-2.2.2.5 Physical Environment, it states that the physical environment shall be designed to support the intended deliver of care model and address the key elements listed. Which discuss lighting, wayfinding, control of the environment and privacy. The focus of this program was on light and view which states, the use and availability of natural light, illumination, and views shall be considered in the design of physical environment. With this guideline, the goal is to allow for each patient to have a view to the outside and to have an increase in light, whether that be having natural light or artificial.

4.3 Finishes

Continuing with the 1.2-2.2.2.5 Physical Environment section, finishes were important part of healthcare facilities. The effect of materials, colors, textures and patterns on patients or residents, staff and visitors shall be considered in the overall planning and design of the facility. Maintenance and performance shall be considered when selecting these items. This guideline can be hard to handle as how is one to control what visitors are wearing but typically neutral

colors will blend better with any color, therefore the color palette of the proposed treatment center is neutral colors. Whites, pale greens, blues, and earth tone colors allow for color control.

4.4 Architectural Details

Moving to section 2.2-2.3.9.1 Architectural Details are highly important guidelines to follow and consider when working with healthcare. This section states that decorative water features shall not be placed inside an oncology/nursing unit, fish tanks shall not be installed in oncology/nursing units and that decorative plants boxes or containers with live plants, dirt, or dried flowers shall not be built inside or immediately adjacent to an oncology/nursing unit. These three simple guidelines are very important to a patient's health and treatment. This can create bacteria and or mold which is detrimental for a critically ill patient and can delay their healing process or cause further complications.

4.5 Space Requirement

In section 2.2-3.10 Cancer Treatment/Infusion Therapy Services the book mentions space requirements. The area for individual patients, and clearances between patients giving. While an individual patient shall have a minimum clear floor of 80 square feet and that there should be a minimum of five feet between beds/treatment chairs. Not only does this give patients their privacy but also for the medical staff to get in with any type of equipment necessary to tend to that patient.

4.6 Hand-Washing Station

What seems to be very important in healthcare facilities are the number of hand-washing stations. In section 2.3-3.10.5 Hand-Washing Stations, one hand washing station shall be provided for every four or fewer patients treatment stations. While both patients and nurses shall

have access to hand sinks and that they should be distributed evenly around the floor. While every private toilet room is provided a hand sink, additional sinks are evenly placed amongst each floor to follow this guideline.

4.7 Diagramming for The Proposed Project.

The previous sections state what are guidelines that should be met when designing healthcare facilities. Since there is a limit on what “nature” objects can be placed inside the facility the goal was to incorporate and bring nature from the outside in, by creating two additional facades to the building which will create the trellis housing climbing vines. As research proves that individuals stress and anxiety decrease when seeing nature, and their moods improve this will benefit both patients and staff. Additionally, interior materials and colors were chosen based on an earth tone palette with neutral and light colors, thus allowing the space to feel brighter and larger. These materials have an organic pattern to them such as leaves, and water, etc. bringing the outside in. Additionally, the treatment center should also be designed to increase the natural light into these buildings but also influence the patient’s healing nature by incorporating daylighting to assist with the healing. The elements will encompass visual sightlines to nature and outside from each patient chair and nurses’ stations. Complying with the daylight floor area by achieving illuminance levels between 300 – 3,000 Lux of 75% of floor space This is found in LEED guide. As this proposed project is not focusing on achieving LEED status, this still can benefit in the same framework LEED provides such as a healthy, highly efficient, and cost saving-green building.

In total, healing architecture is a multifaceted design just like healthcare, that these design choices incorporate patient needs. As healthcare facilities cater to multiple categories on a daily that the overall function of a hospital should run as smoothly as possibly, thus giving staff and

patient the outcome they are wanting. First and foremost, the facility should be designed to accommodate to nurses and doctors who focus on completing their tasks with the number of steps it takes. By decreasing the steps in the staff can focus clearly on the treatment aspect. Secondly the facility should be designed to reduce the stress and anxiety amongst the patients but also reduce the stress amongst the staff. Having increase in natural light verses artificial light, having direct sightlines to outside not only reduces stress but helps with a patients healing.

The following are selected elements on the proposed project:

First Floor:

1. Reception Desk.
2. Waiting Area.
3. Café
4. Conference room with 8 seats.
5. Mechanical Room.
6. Electrical Data.
7. Storage

Fourth Floor:

1. Reception (Check In).
2. Phlebotomy.
3. Lab.

4. Consult Rooms.
5. Toilet Rooms.
6. Nurses Manger.
7. Nurses Station.
8. Clean Supply.
9. Soiled Holding.
10. Work Rooms.
11. Medicine Room.
12. Infusion Stations (Private and Public).
13. Pharmacy.
14. Break Room.
15. Janitors Closet.

Fifth Floor:

1. Work Room.
2. Toilet Rooms.
3. Clean Supply.
4. Soiled Holding.
5. Medicine Room.

6. Nurses Station.
7. Nurses Manager.
8. Infusion Station (Private and Public).
9. Janitors Closet.

5. Proposed Project

5.1 Location

Buffalo, New York is one the largest cities in upstate New York. In Figure 9 shows a great aerial view of the waterfront area of downtown Buffalo. Roswell Park Comprehensive Cancer Center is located close to the heart of downtown. The medical campus is sandwich between Allentown and the Fruit Belt. The site of this proposed cancer treatment center was chosen because:

1. It is in Buffalo, NY which has been titled a city of great neighbors and has wonderful scenery.
2. The site is located on an existing medical campus therefore Roswell's Hospital is adjacent to the site and Buffalo General Medical Center is adjacent to the parcel that Roswell accompanies.



Figure 9 - Buffalo, NY. Aerial View From Downtown Waterfront – Provided From Buffalony.Gov

5.2 Site Analysis

Understanding the site's environment is beneficial in using natural light as a main property in this project. Figure 10 shows the proposed site in black and the surround environmental factors. Knowing where the prevailing winds are beneficial when trying to aim for a passive cooling system but with healthcare guidelines that is not a proper function. This information states that the west/southwest façade of the building will be hit more with winds than the rest of the facades where this could change the design of the west façade.

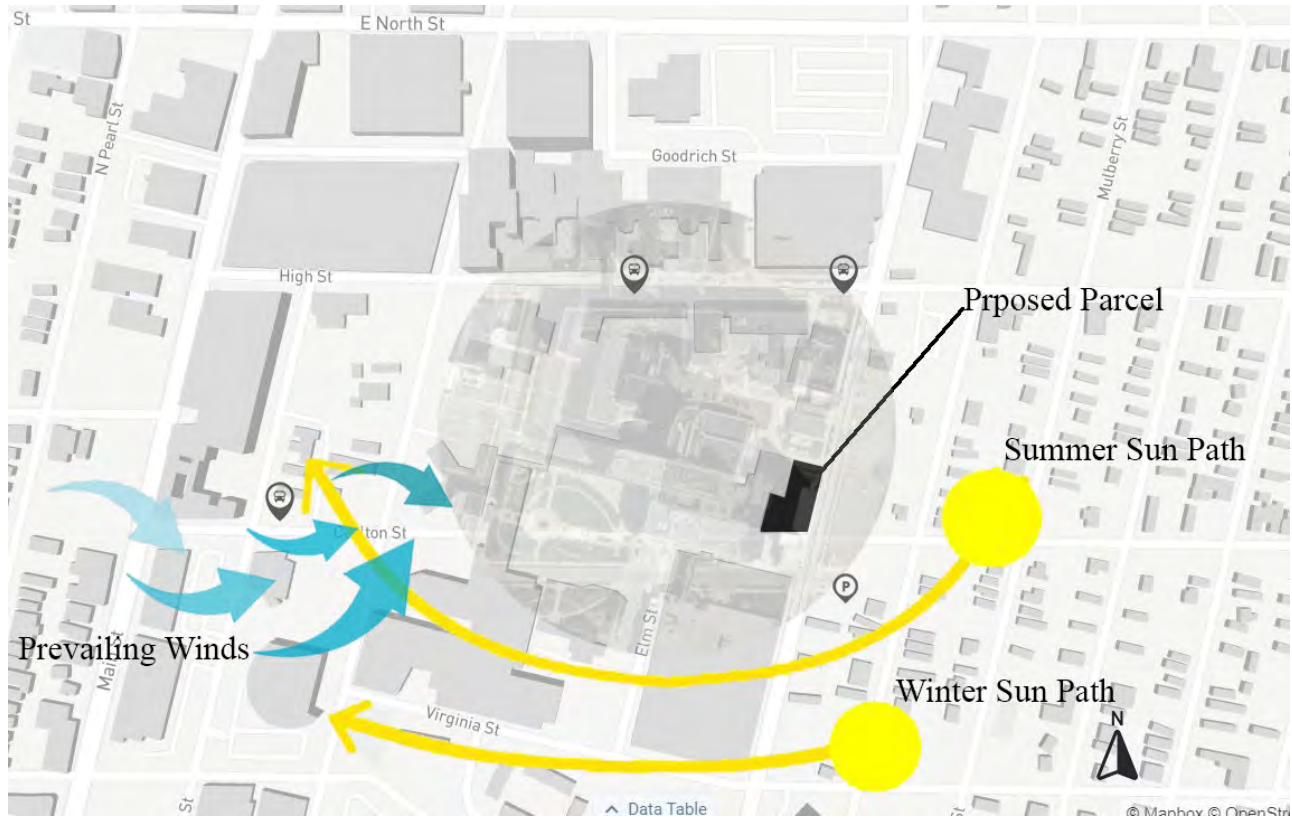


Figure 10 - Site Plan Of Proposed Project Created By Author.

5.2.1 Sun Angles

The sun angles here are highly important to the design as the goal is to increase the use of natural light into the space. With daylighting being a primary asset to the program knowing the sun angles are important to this project. During the summer solstice the elevation of the sun is highest at 1:00 P.M. at an elevation of 70.22 degrees and it is lowest is at 6:00 A.M. at an elevation of 2.78 degrees. The summer solstice is highly important research the sun angles since this is typically when the sun is the hottest with strong ultraviolet rays. The winter solstice is also important to read, with the location of Buffalo, NY and the climate usually being snow during the later months, have the sun angles flood the space is beneficial. The sun is at its highest at 2:00 P.M. at an elevation of 22.82 degrees and is at its lowest at 9:00 A.M. with an

elevation of 1.74 degrees. As many individuals crave for the sun during winter months, having this angle of the sun will help with any type of shading devices as having that winter sun to warm the space. Table 3 - 6 show the sun angles for each season solstice, Spring, Summer, Fall and Winter.

Date:	21/03/2010 GMT-5	
coordinates:	42.8922654, -78.8674216	
location:	42.89226540, -78.86742160	
hour	Elevation	Azimuth
07:17:03	-0.833°	88.82°
8:00:00	7.03°	96.15°
9:00:00	17.8°	106.87°
10:00:00	27.93°	118.9°
11:00:00	36.83°	133.25°
12:00:00	43.62°	150.83°
13:00:00	47.19°	171.66°
14:00:00	46.69°	193.69°
15:00:00	42.26°	213.85°
16:00:00	34.87°	230.6°
17:00:00	25.62°	244.31°
18:00:00	15.3°	255.96°
19:00:00	4.46°	266.51°
19:28:57	-0.833°	271.45°

Table 3 - Spring Equinox Sun Elevation And Azimuth Of Buffalo, NY.
– Provided By Sun Path Calculations - Suneearthtools.Com

Date:	21/06/2010 GMT-5	
coordinates:	42.8922654, -78.8674216	
location:	42.89226540,-78.86742160	
hour	Elevation	Azimuth
05:36:46	-0.833°	56.18°
6:00:00	2.78°	60.1°
7:00:00	12.72°	69.7°
8:00:00	23.29°	78.98°
9:00:00	34.2°	88.56°
10:00:00	45.14°	99.44°
11:00:00	55.68°	113.44°
12:00:00	64.83°	134.45°
13:00:00	70.22°	168.2°
14:00:00	68.64°	207.8°
15:00:00	61.23°	235.67°
16:00:00	51.31°	253.05°
17:00:00	40.53°	265.41°
18:00:00	29.56°	275.58°
19:00:00	18.76°	284.94°
20:00:00	8.42°	294.29°
20:57:49	-0.833°	303.81°

Table 4 - Summer Solstice Sun Elevation And Azimuth Of Buffalo, NY -
Provided By Sun Path Calculations - Sunearthtools.Com

Date:	21/09/2010 GMT-5	
coordinates:	42.8922654, -78.8674216	
location:	42.89226540,-78.86742160	
hour	Elevation	Azimuth
07:01:37	-0.833°	88.33°
8:00:00	9.82°	98.36°
9:00:00	20.47°	109.33°
10:00:00	30.36°	121.84°
11:00:00	38.85°	136.92°
12:00:00	44.98°	155.39°
13:00:00	47.62°	176.84°
14:00:00	46.1°	198.74°
15:00:00	40.83°	218.16°
16:00:00	32.88°	234.12°
17:00:00	23.28°	247.23°
18:00:00	12.78°	258.51°
19:00:00	1.85°	268.9°
19:14:39	-0.833°	271.39°

Table 5 - Fall Equinox Sun Elevation And Azimuth Of Buffalo, NY -
Provided By Sun Path Calculations - Sunearthtools.Com

Date:	21/12/2010 GMT-5	
coordinates:	42.8988565, -78.863836	
location:	42.89885650, -78.86383600	
hour	Elevation	Azimuth
08:43:09	-0.833°	121.97°
9:00:00	1.74°	124.85°
10:00:00	10.11°	135.83°
11:00:00	16.88°	148.15°
12:00:00	21.53°	161.86°
13:00:00	23.59°	176.59°
14:00:00	22.81°	191.53°
15:00:00	19.29°	205.78°
16:00:00	13.42°	218.75°
17:00:00	5.71°	230.31°
17:44:05	-0.833°	238.03°

Table 4 - Winter Solstice Sun Elevation And Azimuth Of Buffalo, NY -
Provided By Sun Path Calculations - Sunearthtools.Com

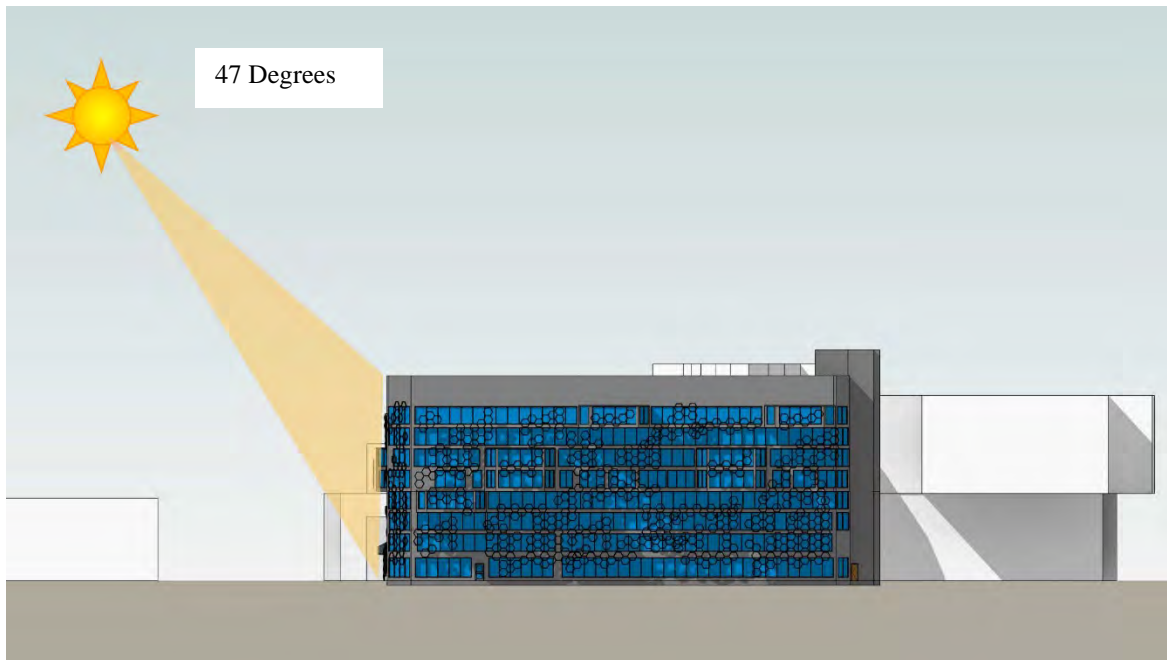


Figure 11 - Spring Equinox Sun Angle - South Façade Designed By Author.

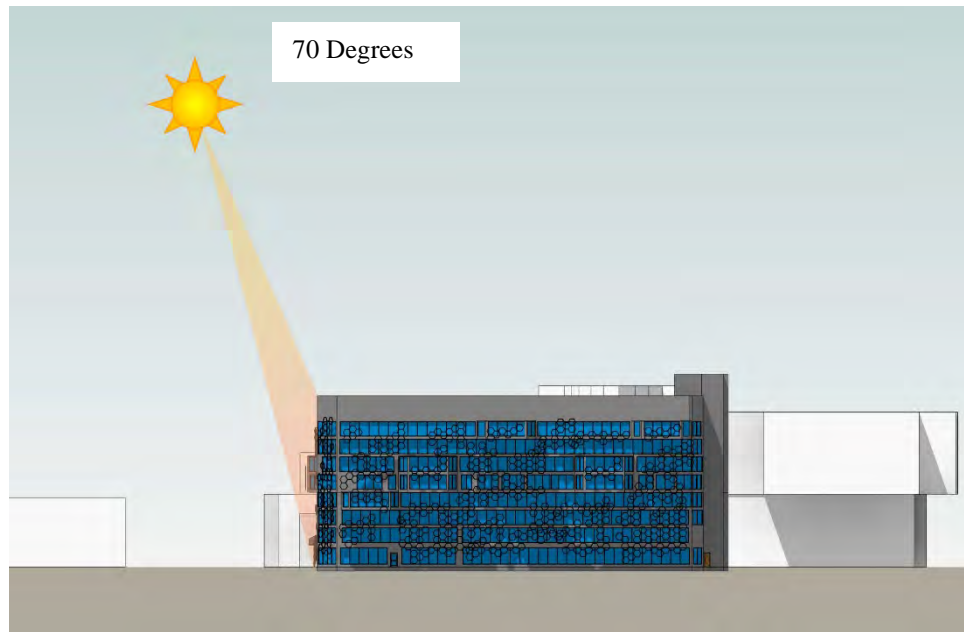


Figure 12 - Summer Solstice Sun Angle - South Façade Designed By Author.

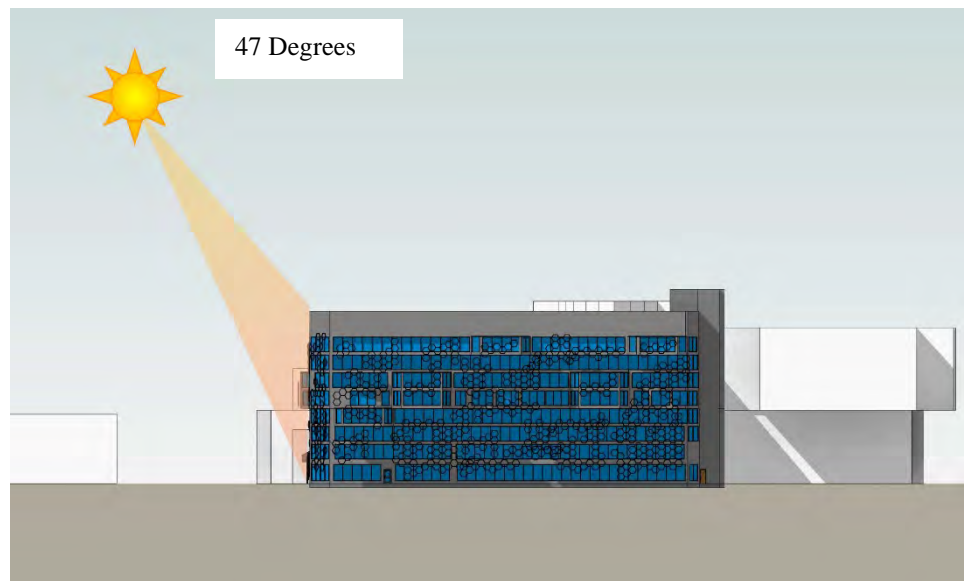


Figure 13 - Fall Equinox Sun Angle - South Façade Designed By Author.

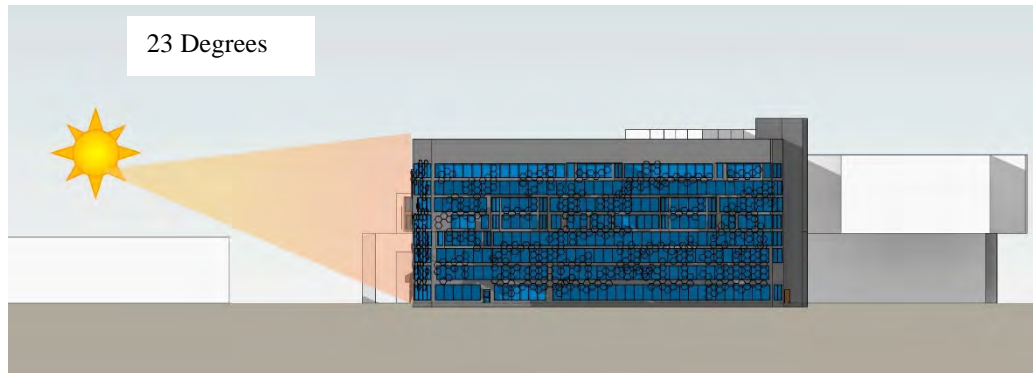
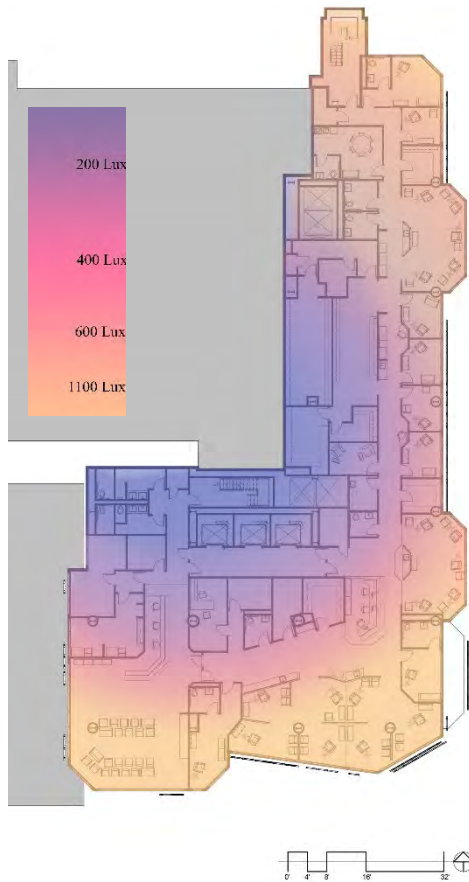


Figure 14 - Winter Solstice Sun Angle - South Façade Designed By Author.

The preceding Figures 11 through 14 show what the sun angles are when during each season. Based on the Tables 3 to 6, they indicate the sun altitude angles for the equinoxes and solstices. The figures resemble the high point the sun reaches and how the sun is hitting that south façade. During the Spring equinox, the sun is at its high elevation of 47 degrees, during the summer solstice is at its highest elevation of 70 degrees which shown in Figure 12. The Fall equinox sun angle is like Spring where it sits around 47 degrees and the winter solstice at 23 degrees.

The sun angles help indicate what type of solar shading devices the building will have. There are no horizontal sun shading devices on the south façade, though the double terrace will act as a shading system as there are opaque colored resin panels that are installed into the trellises that block the summer sun from entering and overheating the interior space.



**Figure 15 - Daylighting Analysis At Spring Solstice
Designed By Author.**



**Figure 16 - Daylighting Analysis At Fall Solstice
Designed By Author.**

The Figures 15 and 16 is a model based of the solar analysis of that specific season. While these models show the daylighting analysis, they show the information based of the entire three-month time frame. The figure shows how far back daylighting can fill the space. During the spring solstice, due to a high elevation and azimuth the daylight reaches mainly the spaces along the exterior wall. The daylighting lux that reaches the outer exterior walls range from 400 to 500 and greater lux which is equivalent to 37 footcandles to 46 footcandles. During the fall solstice with a similar sun elevation but different azimuth the sun depth into the space is increased reaching closer to the core of the building. Allowing for daylighting to reach to different service areas amongst the programs.



Figure 18 - Daylighting Analysis At Summer Solstice Designed By Author.

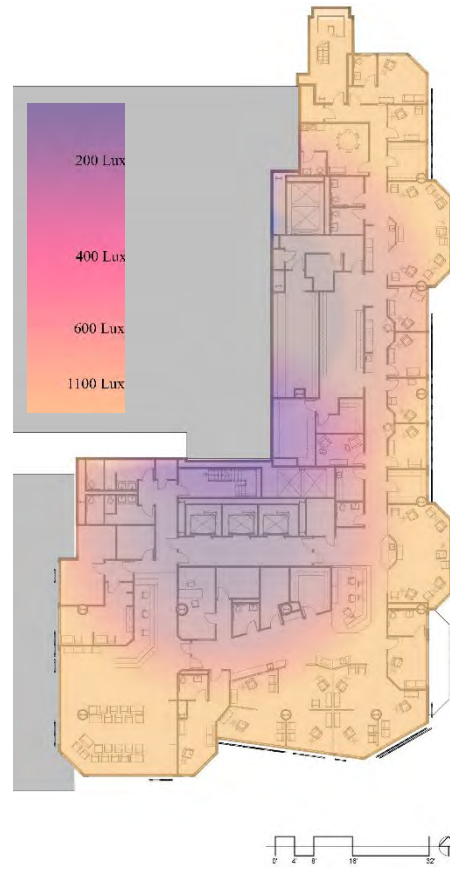


Figure 17 – Daylighting Analysis At Winter Solstice Designed By Author.

Since the angle of the sun is about 70 degrees which reaches close to being directly overhead, therefore the depth of the daylighting does not fill the space. The daylighting lux that starts at that outer exterior wall ranges from 200 to 250 lux which is equivalent to 18-to-23-foot candles which the goal for the infusion chair is 20 footcandles creating just enough illuminance for the space. During the winter solstice the sun angle is lower allowing for the sun to reach further to the core of the building. Since the core of the building is mainly storage rooms and circulation the need for daylighting to fill the space is not necessary.

5.3 Architectural Drawings

5.3.1 Site Plan



Figure 19 - Ground Floor Plan Designed By Author.

The main entrance point is from the south façade entryway off Carlton Street (A). The existing hospital has a passageway (B) that connects with the new proposed building as it allows for patients to enter from the existing hospital as well. With this being a large medical campus there is an existing parking garage south of the building and multiple parking lots around the surrounding building (refer Figure 10). Staff will typically use the passageway entrance to enter the building.

5.3.2 Floor Plans

1- Overall Ground Floor Plan

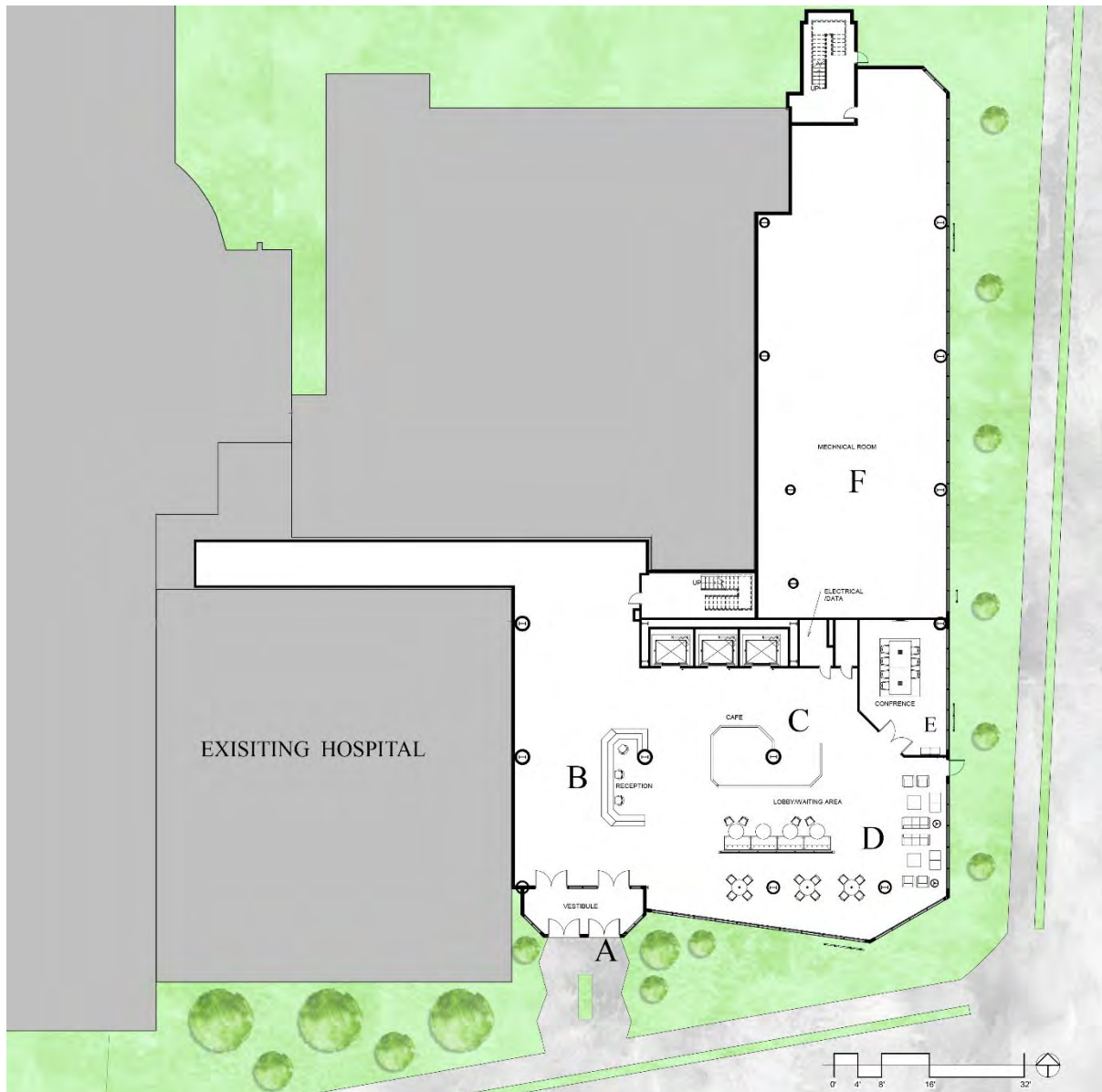


Figure 20 - First Floor Plan Designed By Author.

2- Overall Fourth Floor Plan

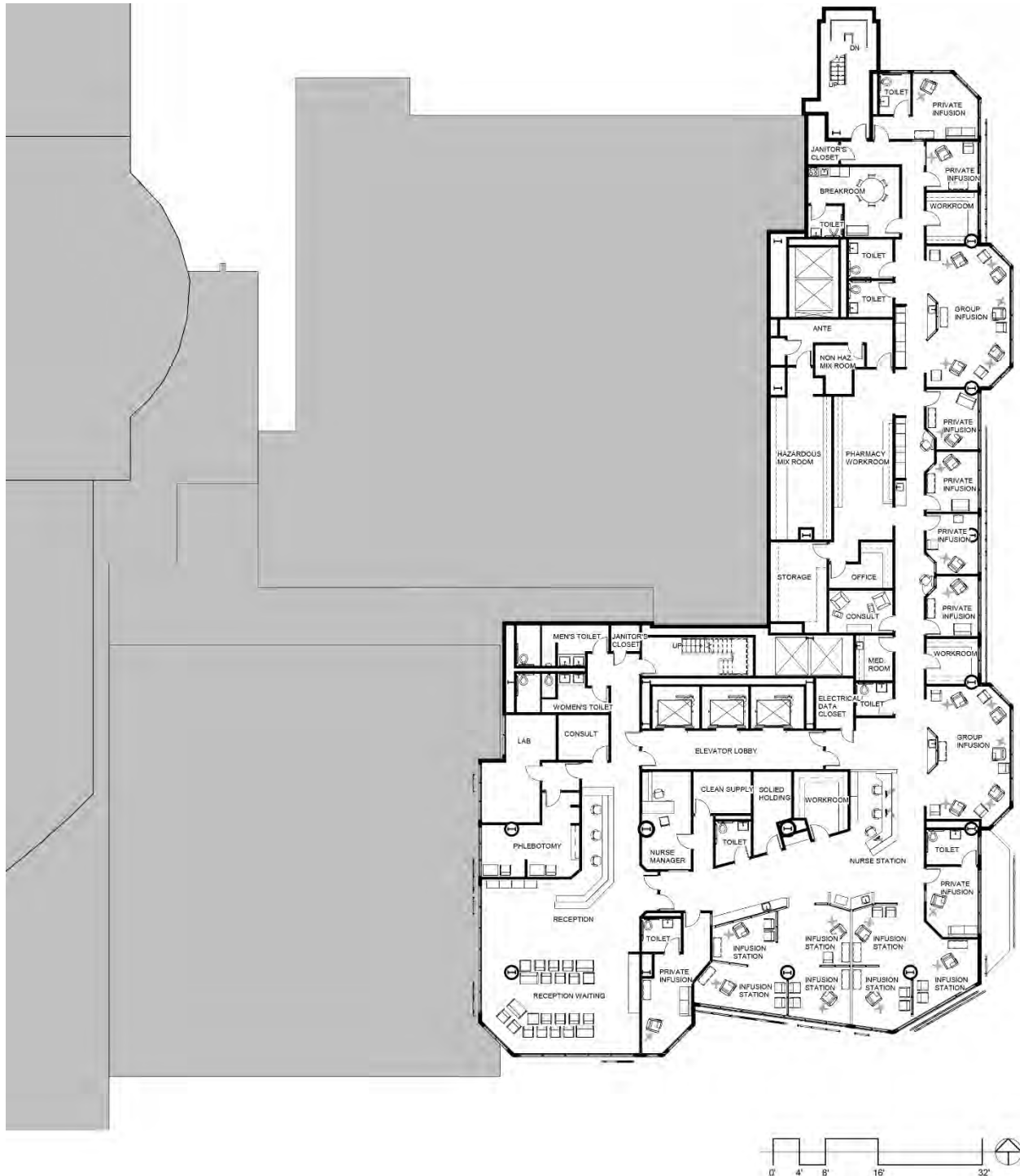


Figure 21 - Fourth Floor Plan Designed By Author.

3- Overall Fifth Floor Plan

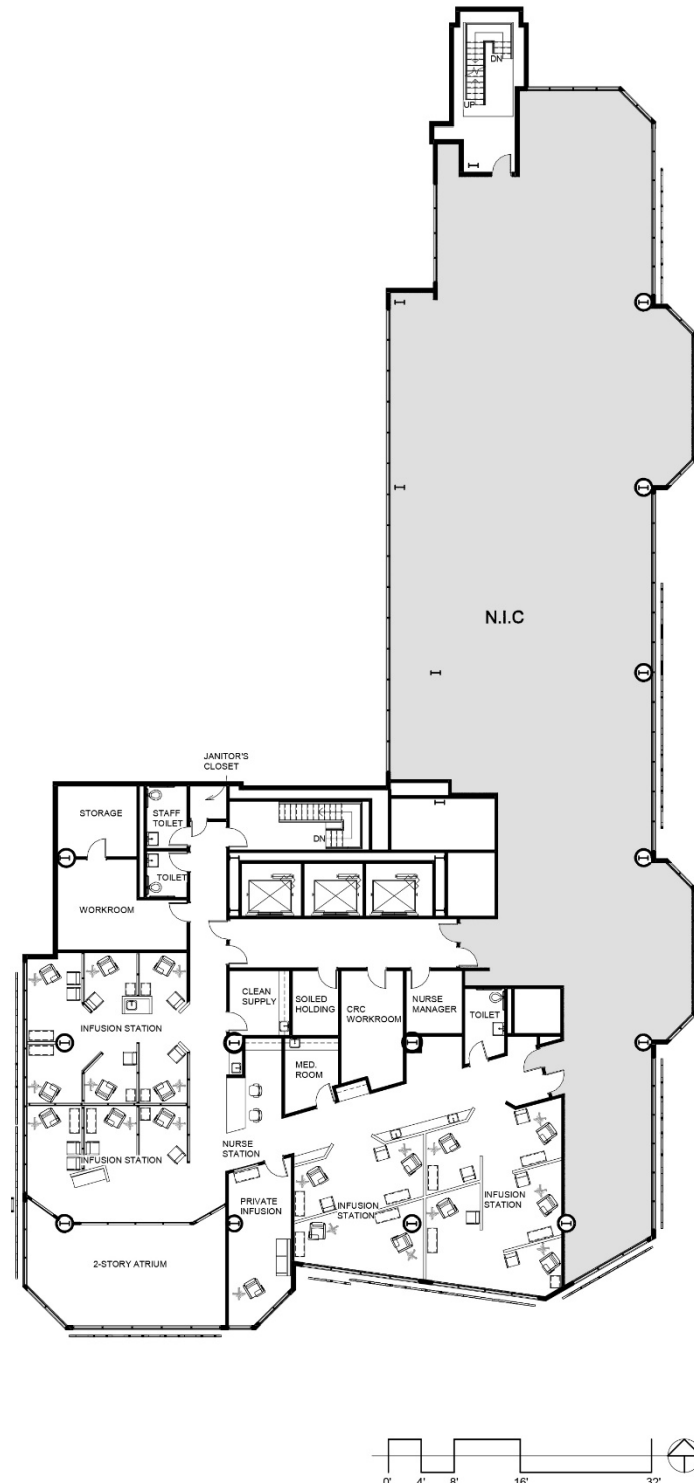


Figure 22 - Fifth Floor Plan Designed By Author.

The shape fills the parcel compared to what the original design was. Keeping a similar plan from what is existing focuses on the nature aspect. While the living trellises on the façade, those plants need soil to grow from, with having the structure designed this way allows for the climbing vines to start growth. With this design it allows for the winter sun angle to reach the ground level as there is a four-story parking garage on the south side of the building which could block sun, and it allows for outdoor seating and space for patients and staff to utilize.

The trellises are created with a hexagonal shape which can be drawn to the molecules that make up medicine. A molecule is a group of two or more atoms held together by chemical bonds which creates this hexagonal shape. This hexagonal shape is shown throughout the space as it starts on the exterior façade and spreads to the interior, reflecting in material patterns, casework detailing and soffits.

Finally, the creating a treatment center for patients undergoing chemotherapy to have a space that can reduce stress by increasing the natural light was the main goal but also creating more group infusion bays and private infusion rooms. This was designed based off interviews with patients.

4- Diagramming for Fourth Floor Plan

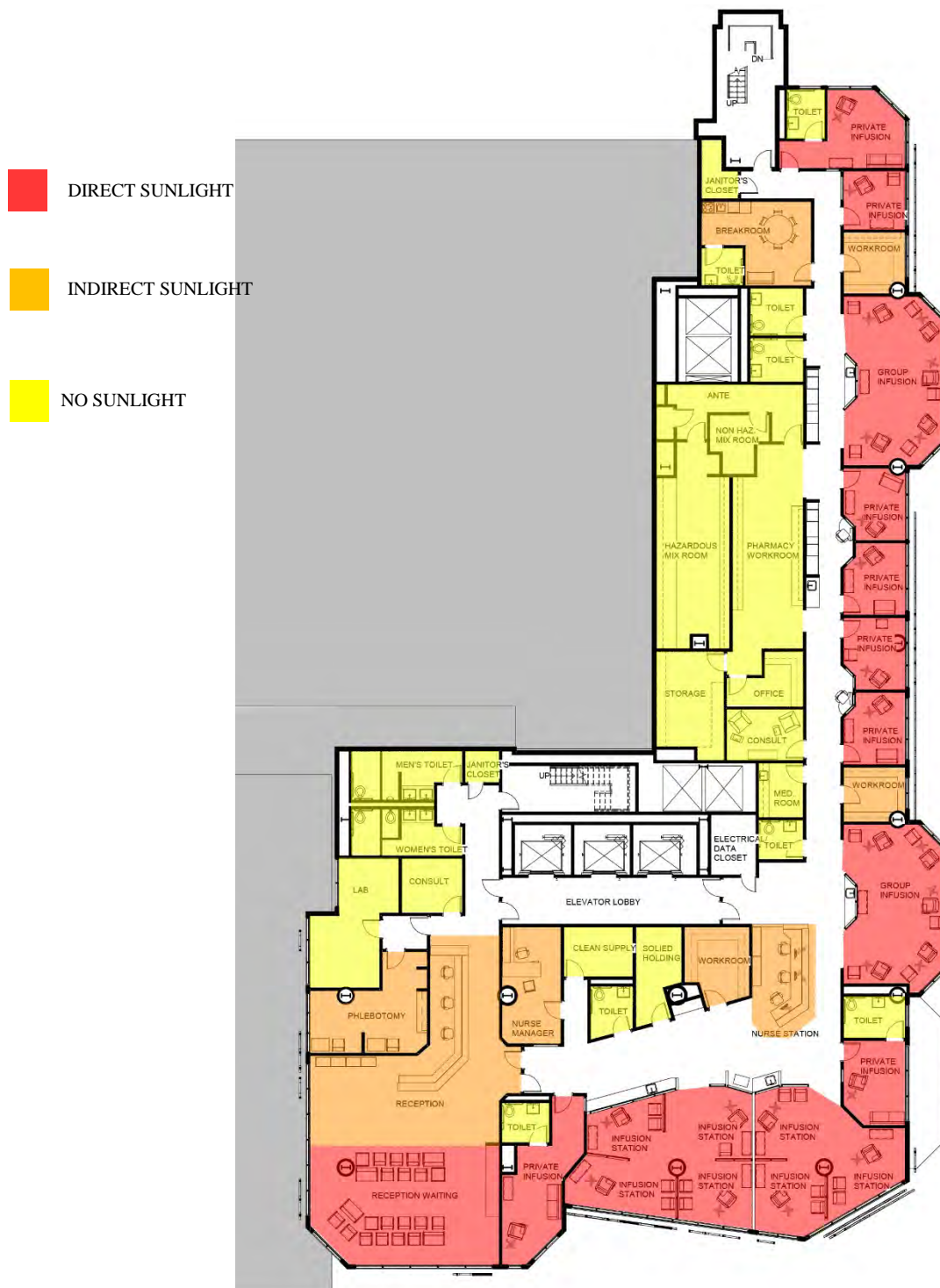


Figure 23 - Space Diagramming For Fourth Floor Plan Designed By Author.

The color blocked fourth floor plan indicates how the space was planned. Prior to starting the design, diagramming which areas would want the direct light to shine in, while the red blocks clearly state that all infusion chairs claim the direct light. This was planned so that all patients gained the most from the daylight and benefit from the healing within. The reception lobby is located with a two-story atrium which allows the light to fill the space. The orange blocks are areas that received the indirect light. These were rooms that had patients but were occupied more by staff. These areas included the nurse's station/manager office, workrooms, phlebotomy, and the staff break room. For the rooms in this color that sat closer to the core of the building had tinted windows allowing for that indirect light to shine in. The tinted windows were a tint to bronze to allow the light to pass through but give enough privacy for the staff. The yellow blocks indicate the rooms that do not need direct light to function properly. Areas like toilet rooms, clean supply, soiled holding, pharmacy, and the lab. Artificial lighting is used in these spaces to complete the tasks. While artificial lighting can affect staff over time, these rooms may be occupied for no more than six hours a day, upon exiting the room there is direct sightlines to the outside. Finding the right balance between which rooms received the right lighting was all based on the lighting chart for hospitals.

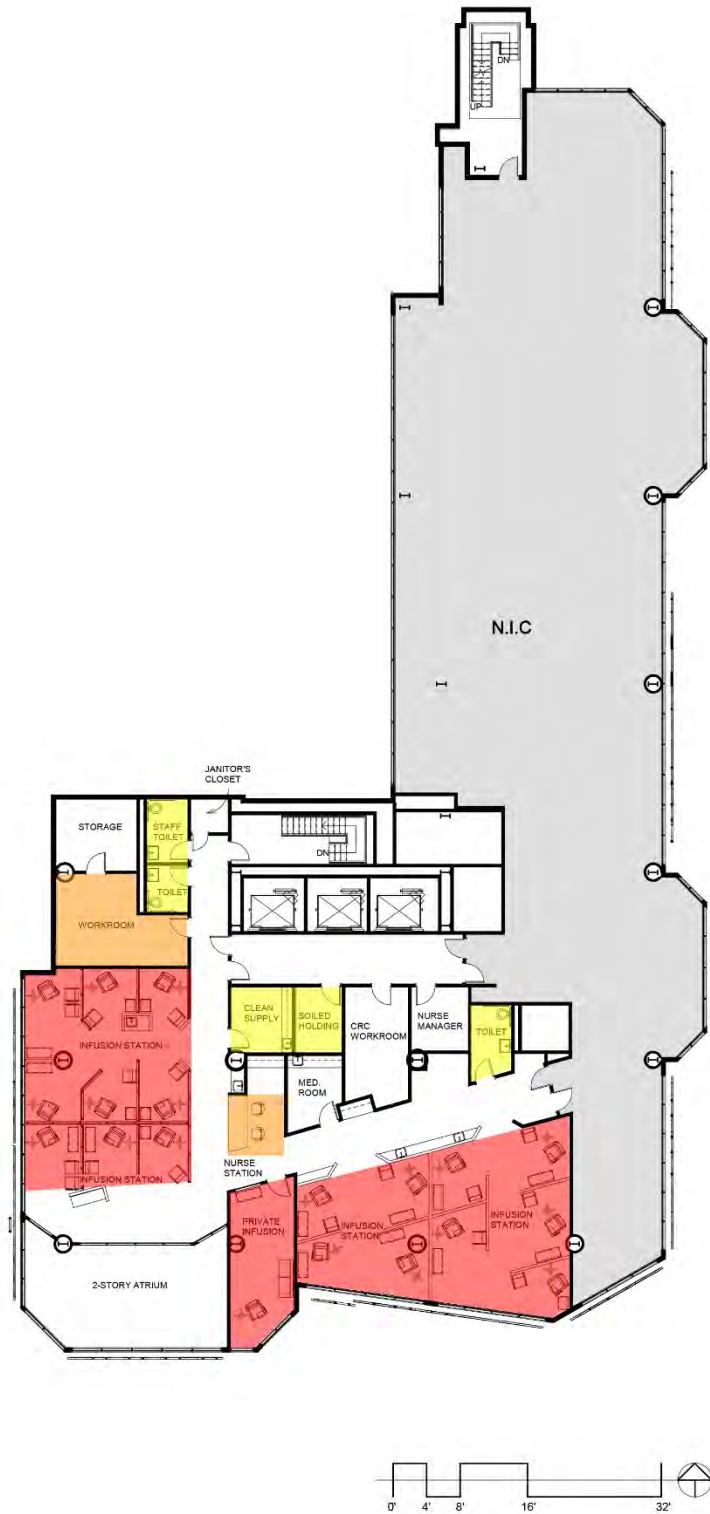
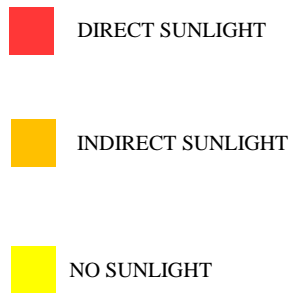


Figure 24 - Space Diagramming For Fifth Floor Plan Designed By Author.

The fifth floor is designed for overflow of chemotherapy stations. While it occupies only half of the floor, the same design process was used. The red blocking shows infusion stations whether they are private or open, all are on the exterior wall. The orange blocks use the indirect light barrowed from the infusion stations and the two-story atrium to receive the same benefits as those on the fourth floor.

5.3.4 Wall Section

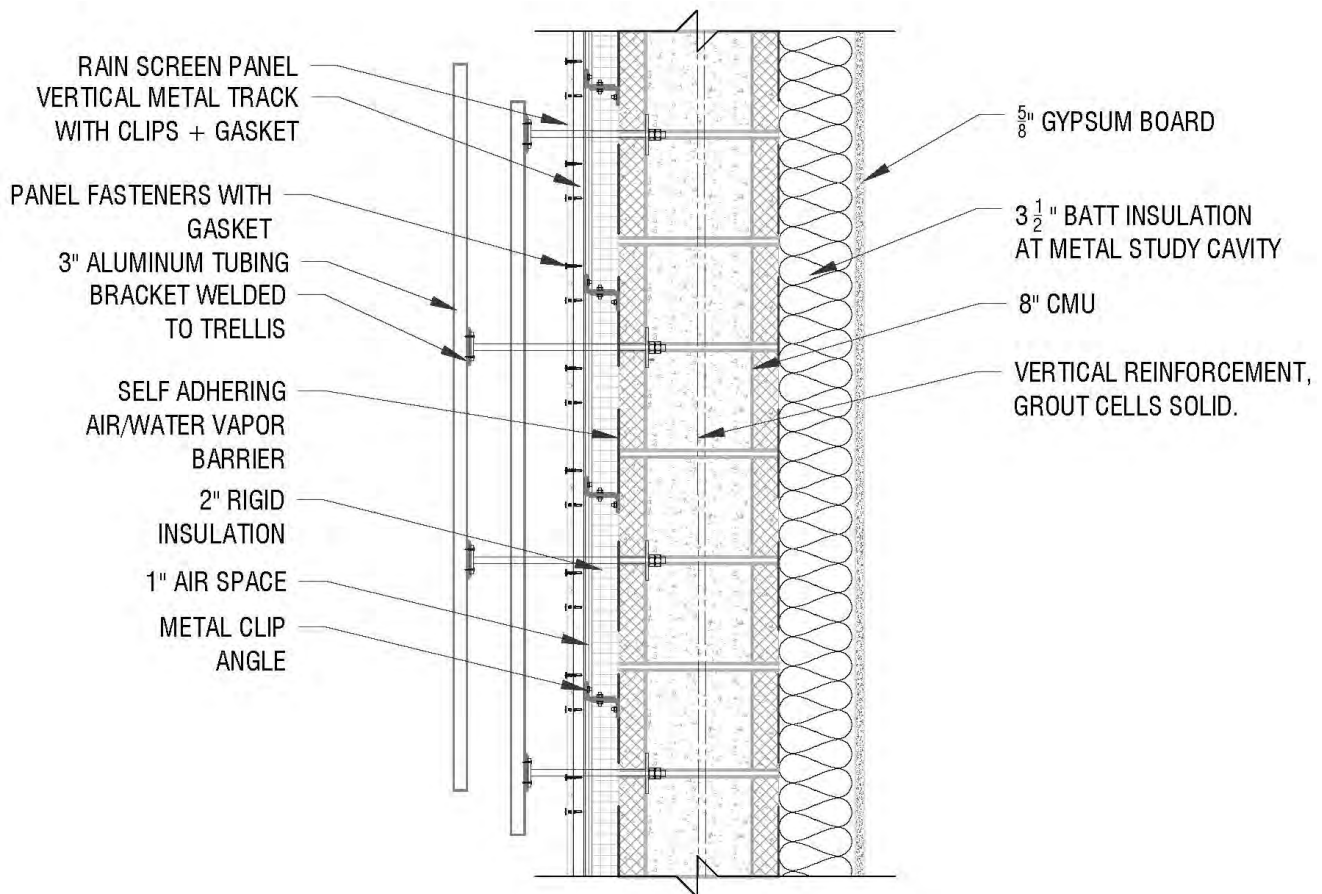


Figure 25 - Exterior Wall Detail Designed By Author.

With the having a double growing façade the wall section in Figure 17 shows the connections between each member. First façade on the structure is a rain screen panel, with high pressure decorate laminate for the external applications which consist of layers of cellulose fibers

impregnated with thermosetting phenolic resins and of one or more surface layers of a special weather protection and chemically bonded together at a high-pressure process. These rainscreen panels are highly durable, they are mounted to the rainscreen mealy track and can easily be replaced if become damaged.

The two living trellises are three-inch aluminum tubing that are prefabricated off site and upon arrival are bolted to the metal brackets that extrude from the structure. Aluminum was considered as it is lightweight materials and can withstand every changing climate. These trellises extrude at max two feet from the finished rainscreen. This allows for cleaning of the main façade and glazing and allows for the climbing vegetation to be further away from the structural aspect of the building. As climbing vegetation can be intrusive and damaging to structural walls, the idea to push them further from the main façade will lessen the chances of damage from the plants.

5.3.5 Rendering Perspectives

1- Exterior Views



Figure 27 – Exterior View Designed By Author.



Figure 28 - Exterior View Of Sunrise Designed By Author.



Figure 26 - Exterior View Designed By Author.





Figure 29 - Exterior View Of Afternoon Sun Designed By Author.



Figure 30 - Exterior Nighttime View Designed By Author.

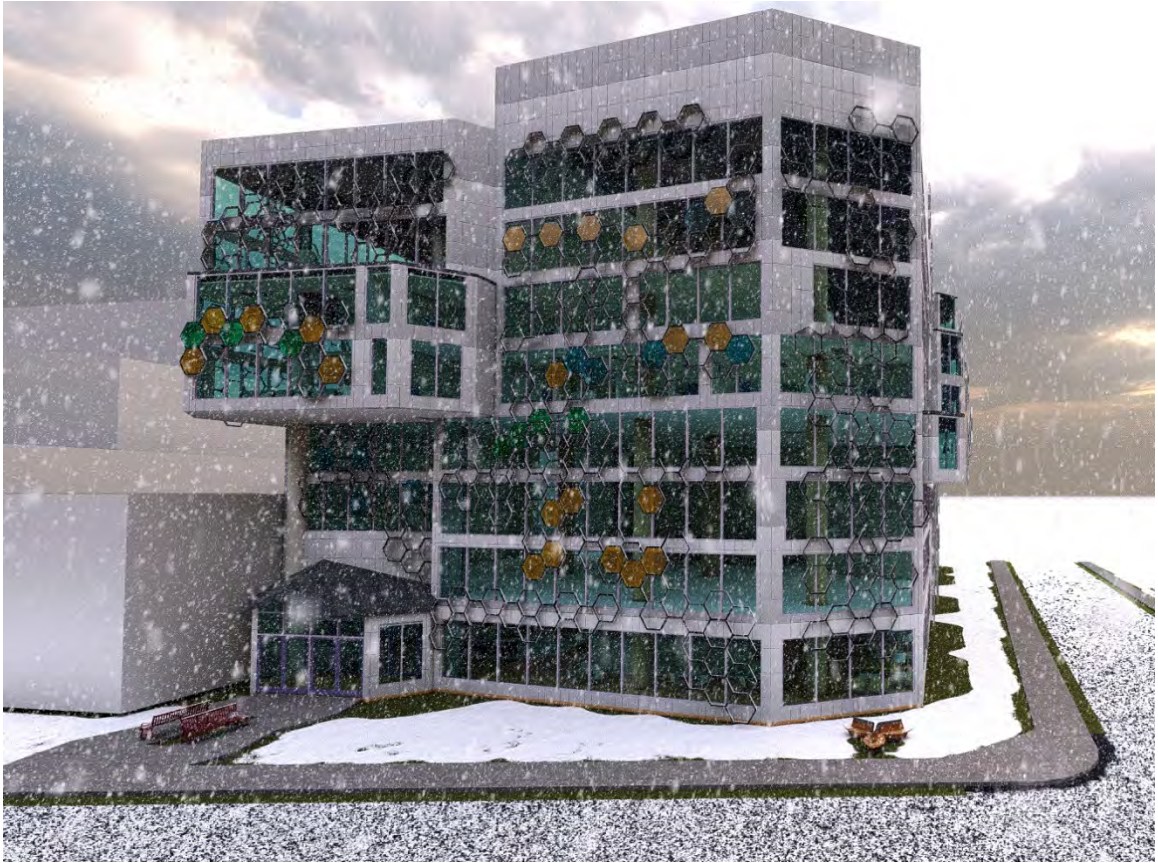


Figure 31 - Exterior View During Snowfall Designed By Author.

2-Interior Perspectives



Figure 32 - Ground Floor Lobby Reception Designed By Author.

The goal for the entrance way reception was to embrace nature, while the color palette was based on earth tones and remained light, the dark laminate wood that covers the reception desk allows for easy wayfinding. Each desk throughout the project is focused on colors enhancing the wayfinding for patients. The ground floor allows for multiple varieties of soft seating for patients, guests and even staff.



Figure 33 - Fourth Floor Infusion Treatment Reception/Check In Designed By Author.



Figure 34 - Fourth Floor Reception Waiting Lobby Designed By Author.

The fourth-floor reception and lobby continue with the natural materials. All flooring throughout the program except for fourth floor reception are heterogeneous sheet flooring which is composed of a comfort base layer, a printed pattern, a performance wear layer, and an additional cultured coating designed to take the activity of healthcare traffic and cleaning. The reception floors are tiled carpet square that are rated for hospitals. The tiled carpet squares allow for easy maintenance and cleaning. All materials on every surface can be cleaned with a bleach solution and will withstand the hospital's traffic.



Figure 36 - Semi-Private Infusion Bays Designed By Author.



Figure 35 - Semi-Infusion Bay Designed By Author.



Figure 37 - Central Nurse's Station Designed By Author.



Figure 38 - Private Infusion Room Designed By Author.



Figure 39 - Group Infusion Designed By Author.

All infusion stations including the group bays have storage units for the patients to place their belongings. These storage units are composed of bleach cleanable laminate and solid surface countertop. Both storage units and casework throughout the project are raised at least a minimum of 10 inches above finished floor to allow for proper janitorial cleaning.

5.3.6 Solar Studies

Solar studies have been captured in infusion stations during all four seasonal solstices. These models are produced in black and white to read clearer as how the light enters the space.

1- Spring Solstice South Façade

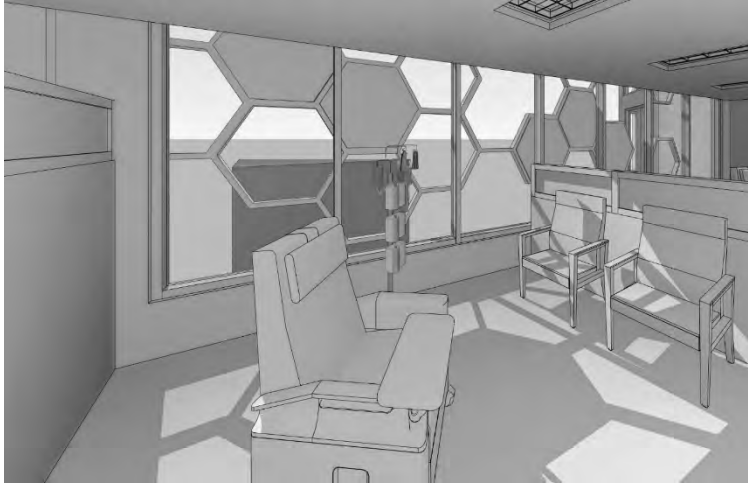


Figure 42 – Spring Solstice, South Façade at 8 a.m.

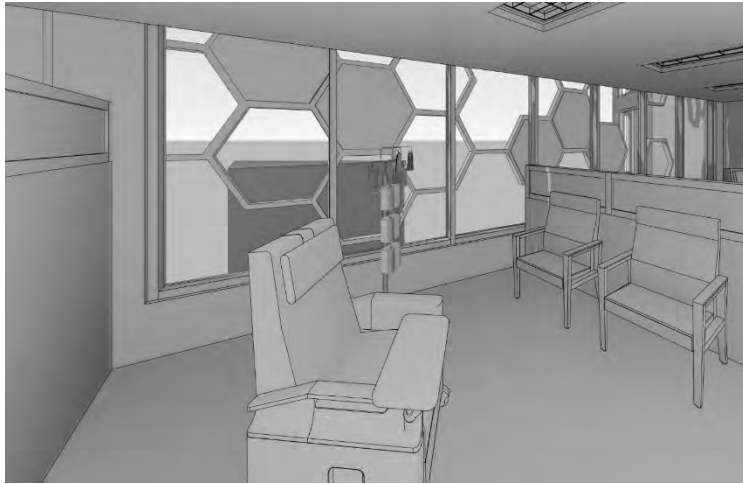


Figure 41 - Spring Solstice, South Facade at 12 p.m.

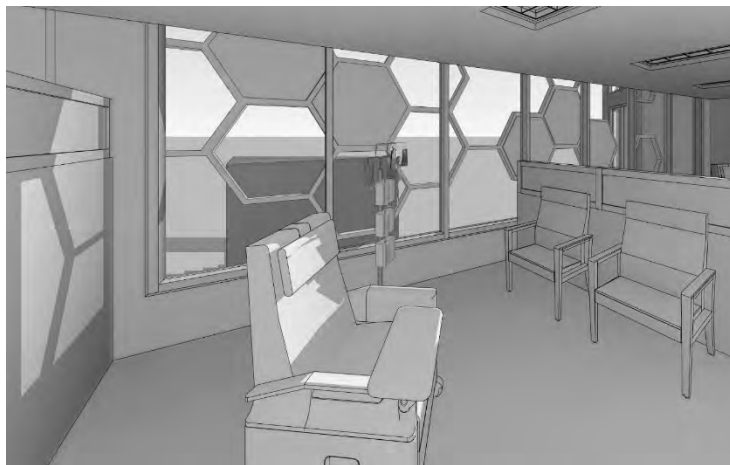


Figure 40 - Spring Solstice, South Facade at 6 p.m.

The Spring solstice indicates that at noon time when the sun is at it is highest the infusion station is filled with light while the pattern of the trellis is replicated on the floor. The opaque resin-colored panels are designed to help block the harsh, unwanted sun rays from entering the space.

2- Summer Solstice South Façade

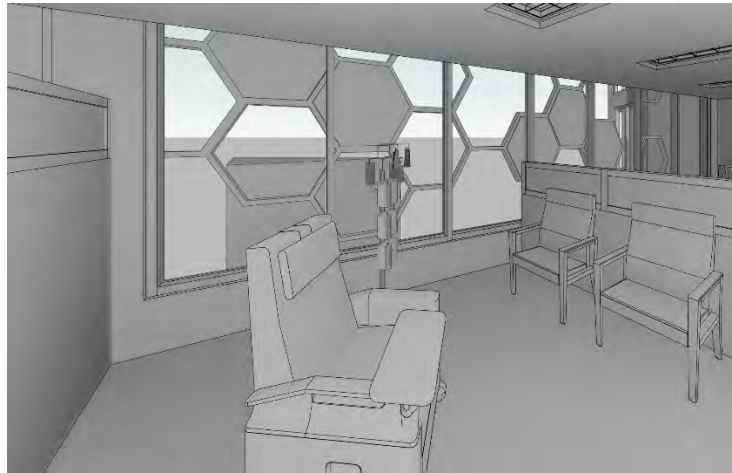


Figure 43 - Summer Solstice, South Façade at 8 a.m.

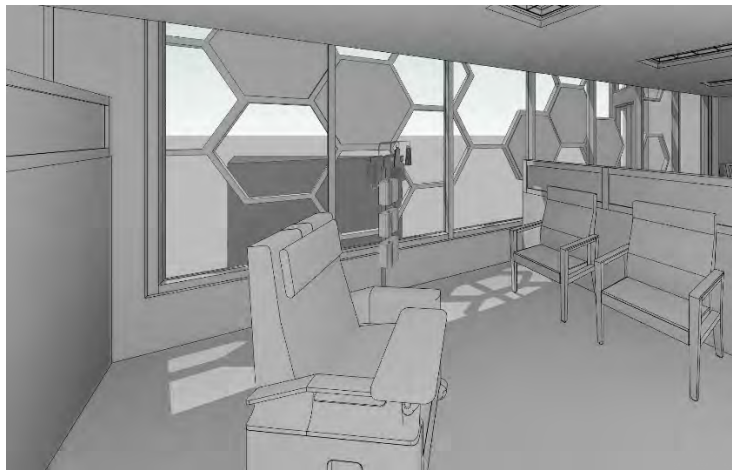


Figure 44 - Summer Solstice, South Façade at 12 p.m.

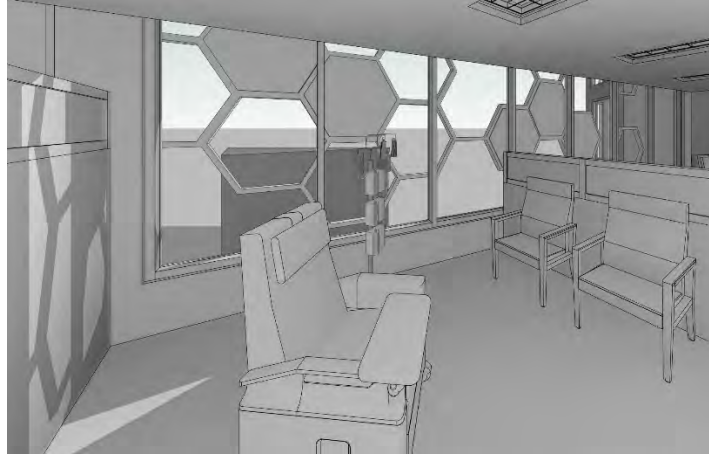


Figure 45 - Summer Solstice, South Facade at 6 p.m.

As indicated from earlier tables and figures the summer sun does not reach deep into the space. This will help with unwanted summer heat gain. As mentioned earlier, the integrated resin panels on the trellis help with the unwanted sun angles.

3- Fall Solstice South Façade

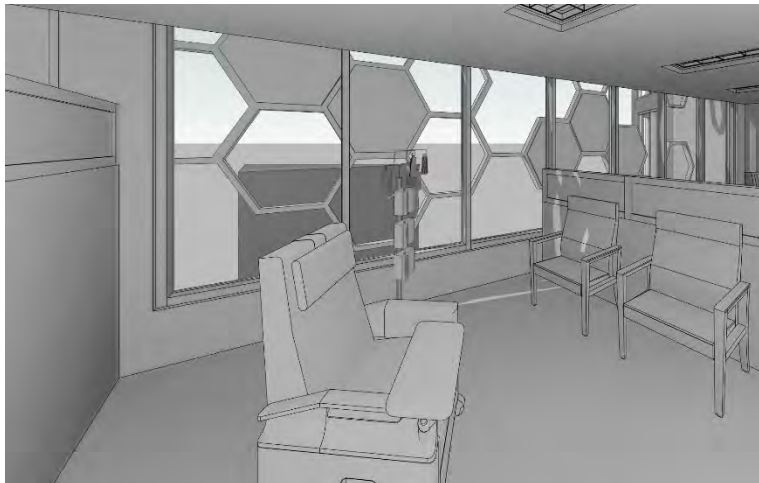


Figure 46 - Fall Solstice, South Facade at 8 a.m.

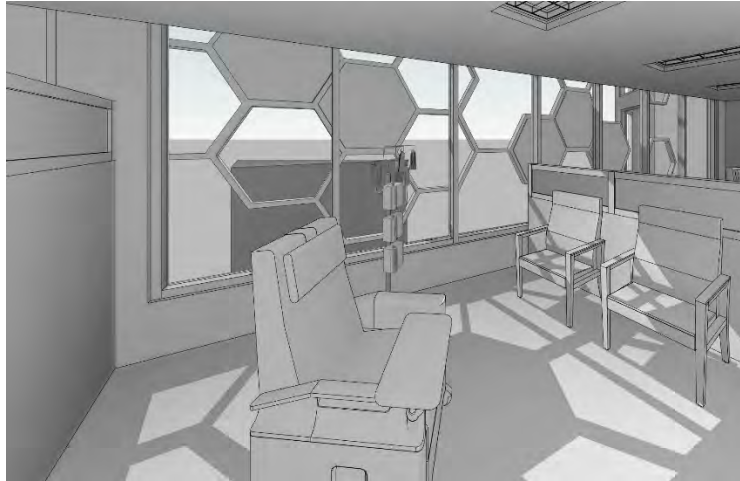


Figure 47 - Fall Solstice, South Facade at 12 p.m.

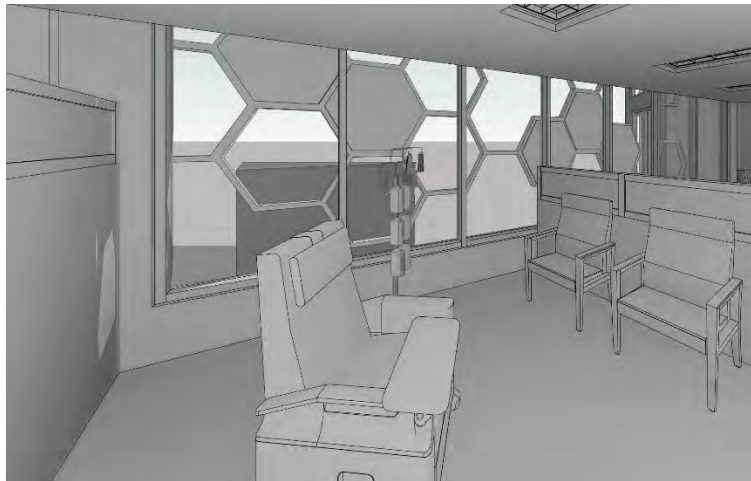


Figure 48 - Fall Solstice, South Facade at 6 p.m.

As the season and weather changes from summer to fall and the temperatures start to drop, individuals aim to find warmth and the sun. At high noon, the fall sun shines deep into the room allowing for the space to passively heat up all while still blocking direct light from the patient.

4- Winter Solstice South Façade

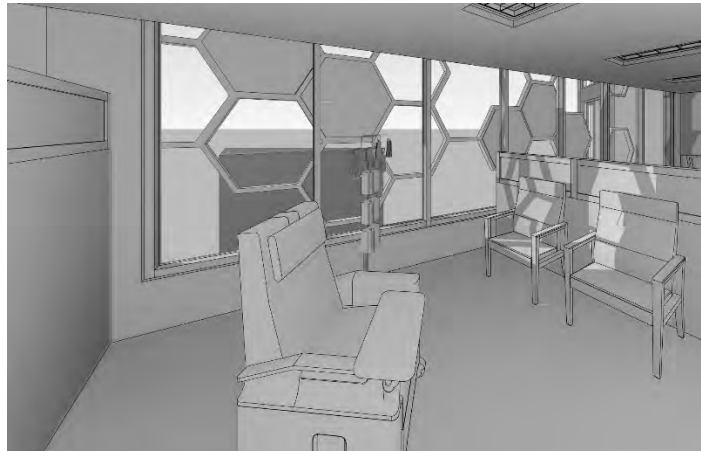


Figure 49 - Winter Solstice, South Façade at 8 a.m.

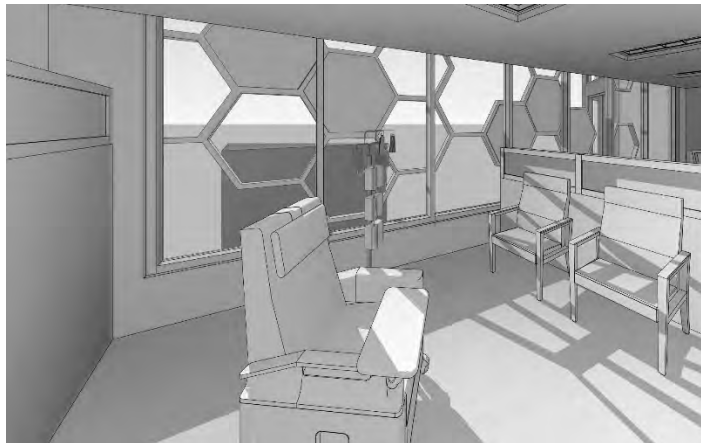


Figure 50 - Winter Solstice, South Façade at 12 p.m.

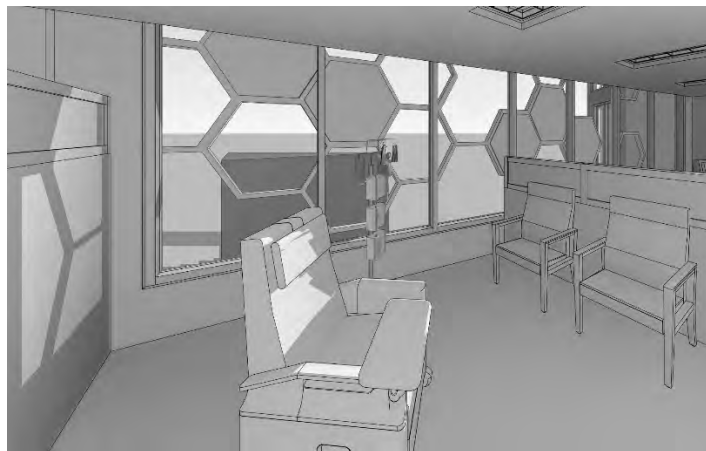


Figure 51 - Winter Solstice, South Façade at 6 p.m.

The winter solstice is when individuals tend to crave the sun and warmth. With the highest elevations of the sun no more than 23 degrees the sun has better access to fill the entire space and reach further to the core of the building.

5 – Morning Sun Angles



Figure 52 - Spring Solstice, East Facade 8 a.m.

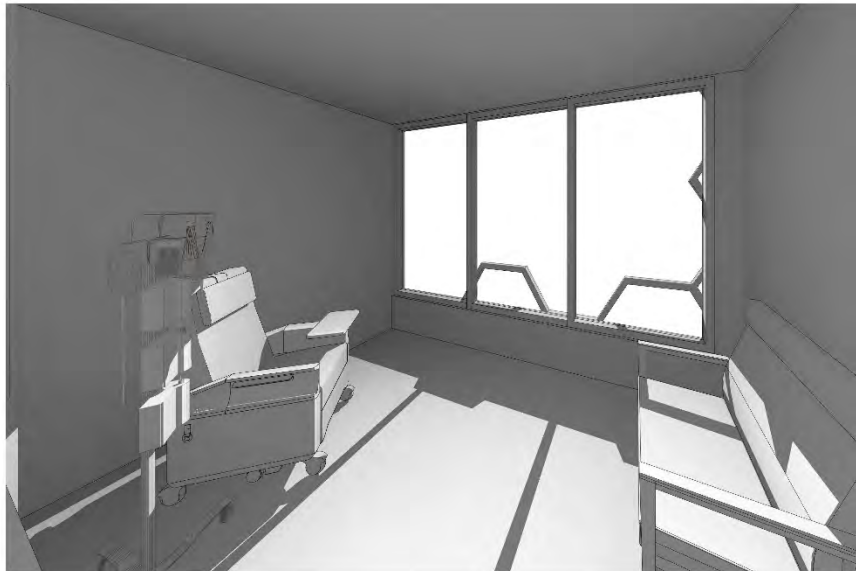


Figure 53 - Summer Solstice, East Facade 8 a.m.



Figure 54 - Fall Solstice, East Facade 8 a.m.



Figure 55 - Winter Solstice, East Facade 8 a.m.

A solar study was also looked at on the east façade of the building, as Figures 52 to 55 are only shown due to this being the morning sun. As the sun rise in the east and sets in the west the rooms along the east façade usually get sun as early as 5:30 a.m. to 10:30/11 a.m. as the sun starts to shift westward. Interior solar blinds are designed into each infusion bay allowing the patient to have full access and control over the amount of daylight into the space.

6. Measures of Success

With the understanding that healthcare is evolving over time and catering to patient's needs, the benefits of healing architecture can impact a patients recovery time and overall experience. Through studies of EBD, greener and healthy hospitals are becoming the new norm. This EBD stresses the benefits of what nature and daylight can do for a patient. Reducing stress levels, depression, anxiety and overall improve their mood, physically shows. By giving patients a window, a view to the outside, or a simple picture of nature can psychologically and physically heal a patient. Studies show that including nature inspired designs, influence a patient's recovery such as strengthening the immune system.

While cancer patients usually spend about two to eight hours a day in chemo, the natural balance of their circadian rhythm is important to keep their immune system functioning properly. With the increase in daylighting and through solar analysis, studies show that during the morning and afternoon is when a person has the most energy which is typically when patients receive chemo. Even though the patients are sitting for infusion it can psychologically keep a person active and happy. While during the evening a person begins to get ready for rest which is also a huge benefactor for keeping a healthy immune system.

According to Table #2 the following spaces are designed to allow daylight on a recommended illuminance for healthcare rooms. This chart focuses on areas that are specific to the proposed project such as patient rooms, nurses' stations, corridors, and work areas. Based on information provided by article Useful Daylight Illuminance.

Daylight Illuminances less than 100 lux are generally considered insufficient and must have artificial lighting.

Daylight Illuminances in the range of 100-500 lux are considered effective and can be the main source of illumination and or have artificial lighting.

Daylight Illuminances in the range of 500-2000 lux are often perceived as desirable.

Daylight Illuminances higher than 2000 lux liked to produce visual discomfort.

The idea of being connected to nature for the sole purpose of healing and working with specific guidelines that reduced the reality adding nature to the interior. With guidelines for healthcare facilities and working with regulations of no aspect of living nature in an oncology space can limit the amount of nature inside. Through materials with patterns of nature like design and windows allows for the patient to fully feel one with the nature.

LEED's daylit floor area by achieving illuminance levels between 300 – 3,000 Lux of 75% of floor space and based off lighting analysis in figures 15 through 17 show that the levels of Lux in both fourth and fifth floor plans range between 200- 600 lux. Which referring to Table 2 indicates that the foot-candles for that said work area/activity is either achieving that goal or more.

7. Conclusion

Cancer treatment centers are just one of many areas hospitals focus on caring for the patient. During this time, the immune system is weak and everyday tasks are a marathon for a cancer patient. The current project aids that incorporating daylighting and nature into these facilities that it can help reduce stress, depression, and anxiety not only in the staff but also the patients. Protecting and increasing the immune system of a cancer patient is highly important for their fight against this disease and can be done through healing architecture.

In Recognition

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Appendix A

Interviews with patients to understand their insight during chemo treatment. Below is the questionnaire I have written up to give to patients, the bolded text are their answers.

The topic of my thesis is to create a new facility that incorporates daylighting to aid in the healing process for cancer patients. Please do not feel the need to answer every question but please be 100% truthful when doing so. Your answers will not be shared with the facility you attend, this is for my evidence based and researched design thesis. Thank you again for helping me.

Name: **Phyllis Eddy**

1. While receiving chemo, were you in a private room or a room with others (infusion bay)? **I was in a large room with others.**

2. Do you prefer private or open infusion?

It's hard for me to say since I went through chemo during covid and there were very few people in the space when I was there and we were not near each other, nor were visitors allowed. I think I would like the option of either on any given day. Part of me like the option of chatting with other people but I also enjoy alone time that I can do whatever I want with that time. I would bring my crocheting, tablet for reading or Netflix, and magazines. I was almost glad visitors were not allowed because I like to use any time I have for my "sitting" activities and the thought of having someone I care about sit with me during that time was not something I wanted for them. However, I can totally understand if someone had to travel a distance for their treatments that that would be a convenience. Private rooms might be nice at times because I do not enjoy sitting and listening/eavesdropping on other peoples conversations.

3. Where is your station located? (Dark corner, near a window?)

It was a big open room with windows on 2 sides. Stations are located all around the perimeter of the room. Some faced windows but they were across the room and blocked by other stations. The stations that were on the window side faced inward. I remember commenting at one point that the chairs should be turned to face the windows.

4. If you are near a window what is the view like? (Buildings, vegetation, parking lot?)

The long wall of windows faced the parking lot. The short wall may have had grass and trees but it did not provide any great view because the stations in front of them faced inward and there were no stations facing that end.

5. What type of amenities did they have for you (television, books, puzzles etc.)

It was during covid so I never saw anything or was offered anything. They did have heated blankets and pillows (not heated) that were offered. Snacks were offered and drinks . If you were there during lunch, soup was brought in. I think that if it

was not during covid, you could have gotten up and helped yourself, but that was not the case when I was there.

6. How long is your treatment last?

Up to 4 hours

7. How do you usually feel during infusion (mentally/emotionally)?

I feel fine. I used it as my time to do the sitting things that I enjoy doing but usually feel guilty about. Crocheting, Netflix, reading, HGTV magazine. I always brought my own headphones for Netflix show

8. What would you like to see change?

I would like to see the bell in the infusion center, not in the main lobby. I never even noticed it until months after my treatments were over.

More esthetically pleasing room. Walls were beige. Pictures on walls were hung too high. They should be at eye level to enjoy and they should be updated periodically.

Pretty garden or landscape outside the windows. Chairs should be facing directly out and not from opposite of room with equipment in the way.

9. May I share your name in my thesis?

Certainly.

10. Additional comments

Keep in mind that my experience was in the thick of Covid so things may be a little different normally. I never met or talked to any other patients. They were too far away and we all had masks on and didn't leave our chairs except to use the bathroom. Coffee, snacks, etc were brought to us where normally I think you could get up and help yourself.

I can definitely say that I would have liked the room to be more esthetically comfortable - it was very cold and impersonal. The bathroom had a very nice hand painted mural but other than that the artwork was outdated and ugly.

The colors on the walls should be either soft and soothing or feel good rich invigorating colors. The walls should have interesting things to look at and be positioned at a height that makes sense given you are primarily sitting.

Some nice furniture (not sterile, hospital furniture) with a social area for chatting and meeting other patients. Maybe a puzzle set up to encourage interaction or a table to eat lunch at.

Definitely some private areas for quiet space. There were no visitors allowed when I was there, but I think it might be nice to have a quiet space if you wanted to be alone and didn't want to listen to other conversations.

I just recently bought myself a light therapy lamp. It might be nice to have some of those available. I was there mid morning to mid afternoon. I would have liked to be more invigorated. It seems like it was mostly set up to rest.

The topic of my thesis is to create a new facility that incorporates daylighting to aid in the healing process for cancer patients. Please do not feel the need to answer every question but please be 100% truthful when doing so. Your answers will not be shared with the facility you attend, this is for my evidence based and researched design thesis. Thank you again for helping me.

Name: **Elise Puckhaber**

1. While receiving chemo, were you in a private room or a room with others (infusion bay)? **It's almost like a cubicle**
2. Do you prefer private or open infusion?
It depends on the day and how I feel. If it was available to use that day I would prefer a private room.
3. Where is your station located? (Dark corner, near a window?)
It depends on where you were in the center, in certain areas there are windows and depending on what chair you have you would either see other buildings and/or mostly city views.
4. If you are near a window what is the view like? (Buildings, vegetation, parking lot?)
Depending on what side of the building you were at you had other buildings or downtown Buffalo.
5. What type of amenities did they have for you (television, books, puzzles etc.)
Just a tv...nothing to do, you would have to bring your own things if you wanted to do something else.
6. How long is your treatment last?
Anywhere between 4-6 hours
7. How do you usually feel during infusion (mentally/emotionally)?
Again I think this goes back to on the day I was having, sometimes I would feel okay and there were days that were definitely discouraging but I have a wonderful support system which really gets me through this process.
8. What would you like to see change?
More pleasing views internally, better colors.
9. May I share your name in my thesis?
Of Course!
10. Additional comments

I personally did not mind the views that I had, it kind of helped me only because I am a busy body and like to see action of what's always going on. I grew up here and love the active of the city this helped me get through my toughest days.

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